CONTRA COSTA CLEAN WATER PROGRAM

Stormwater Quality Requirements for Development Applications

Stormwater C.3 Guidebook

SECOND EDITION—MARCH 2005

Stormwater C.3 Guidebook

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Glossary

Best Management Practice (BMP)	Any procedure or device designed to minimize the quantity of pollutants that enter the storm drain system. See Chapter Two for a discussion of the various types of BMPs.
C.3	Provision, added in February 2003, of the San Francisco Bay Regional Water Quality Control Board's (see) stormwater NPDES permit (see). Requires each Discharger (see) to change its development review process to control the flow of stormwater and stormwater pollutants from new development sites. Order R2-2003-0022.
California Association of Stormwater Quality Agencies (CASQA)	Publisher of the California Stormwater Best Management Practices Handbooks, available at www.cabmphandbooks.com. Successor to the Storm Water Quality Task Force (SWQTF).
California BMP Method	A method for determining the volume of treatment BMPs. Described in Section 5.5.1 of the California Stormwater Best Management Practice Manual (New Development) (CASQA, 2003).
Compensatory Mitigation	Treatment of an equivalent pollutant loading or quantity of stormwater runoff or other equivalent water quality benefit, created where no other requirement for treatment exists, in lieu of on-site treatment BMPs.
Conditions of Approval (COAs)	Requirements a municipality may adopt for a project in connection with a discretionary action (e.g., adoption of an EIR or negative declaration or issuance of a use permit). COAs may include features to be incorporated into the final plans for the project and may also specify uses, activities, and operational measures that must be observed over the life of the project.
Contra Costa Clean Water Program (CCCWP)	CCCWP is established by an agreement among 19 Contra Costa cities and towns, Contra Costa County, and the Contra Costa County Flood and Water Conservation District. See Dischargers. CCCWP implements common tasks and assists the member agencies to implement their local stormwater pollution prevention programs.
Design Storm	A synthetic rainstorm defined by rainfall intensities and durations. See Chapter Two.
Detention	The practice of holding stormwater runoff in ponds, vaults, within berms, or in depressed areas and letting it discharge slowly to the storm drain system. See infiltration and retention.
Directly Connected Impervious Area	Any impervious surface which drains into a catch basin, area drain, or other conveyance structure without first allowing flow across pervious areas (e.g. lawns).

Direct Infiltration	Infiltration via methods or devices, such as dry wells or infiltration trenches, designed to bypass unsaturated surface soils and transmit runoff directly to groundwater.
Dischargers	The agencies named in the stormwater NPDES permit (see): Contra Costa County, Contra Costa County Flood Control and Water Conservation District, City of Clayton, City of Concord, Town of Danville, City of El Cerrito, City of Hercules, City of Lafayette, City of Martinez, Town of Moraga, City of Orinda, City of Pinole, City of Pittsburg, City of Pleasant Hill, City of Richmond, City of San Pablo, City of San Ramon, and City of Walnut Creek. In addition, three Contra Costa cities within the jurisdiction of the Central Valley Regional Water Quality Control Board have agreed to implement C.3 provisions under the same schedule: City of Antioch, City of Brentwood, and City of Oakley.
Drawdown time	The time required for a stormwater detention or infiltration BMP to drain and return to the dry-weather condition. For detention BMPs, drawdown time is a function of basin volume and outlet orifice size. For infiltration BMPs, drawdown time is a function of basin volume and infiltration rate.
Exemption	Exemption from the requirement to provide compensatory mitigation may be allowed for projects that meet certain criteria set by the RWQCB. These projects must, however, show impracticability (see impracticable) of on-site treatment BMPs and also show that the costs of compensatory mitigation would place an "undue burden" on the project.
Flow-based BMPs	Stormwater Treatment BMPs that remove pollutants from a moving stream of water through filtration, infiltration, adsorption, or biological processes.
Head	In hydraulics, energy represented as a difference in elevation. In slow-flowing open systems, the difference in water surface elevation, e.g., between an inlet and outlet.
Hydrograph	Runoff flow rate plotted as a function of time.
Hydrograph Modification Management Plan (HMP)	As required by Provision C.3 provisions of the Stormwater NPDES permit, a draft HMP must be submitted by November 15, 2004 and an HMP must be submitted by May 15, 2005. The HMP, once approved by the RWQCB, will be implemented so that post-project runoff shall not exceed estimated pre-project rates and/or durations, where the exceedance would result in increased potential for erosion or other adverse impacts to beneficial uses.
Hydrologic Soil Group	Classification of soils by the Natural Resources Conservation Service (NRCS) into A, B, C, and D groups according to infiltration capacity. See Appendix C.

Impervious surface	Any material that prevents or substantially reduces infiltration of water into the soil. See discussion of imperviousness in Chapter Two.
Impracticable	As applied to on-site treatment BMPs, technically infeasible (see) or excessively costly, as demonstrated by set criteria.
Infeasible	As applied to on-site treatment BMPs, impossible to implement because of technical constraints specific to the site.
Indirect Infiltration	Infiltration via facilities, such as swales and bioretention areas, that are expressly designed to hold runoff and allow it to percolate into surface soils. Runoff may reach groundwater indirectly or may be underdrained through subsurface pipes.
Infiltration	Seepage of runoff through the soil to mix with groundwater. See retention.
Infiltration Device	Any structure that is designed to infiltrate stormwater into the subsurface and, as designed, bypasses the natural groundwater protection afforded by surface or near-surface soil.
Integrated Management Practice (IMP)	A BMP that provides small-scale treatment, retention, or detention and is integrated into site layout, landscaping and drainage design. See Low Impact Development.
Integrated Pest Management (IPM)	An approach to pest management that relies on information about the life cycles of pests and their interaction with the environment. Pest control methods are applied with the most economical means and with the least possible hazard to people, property, and the environment.
Intensity-duration-frequency (IDF)	An adjunct to the rational method (see), IDF allows calculation of the governing rainfall intensity based on the estimated time required for runoff flows from the farthest point of a drainage area to reach the point where peak flows are to be determined.
Lead Agency	The public agency that has the principal responsibility for carrying out or approving a project. (CEQA Guidelines §15367).
Low Impact Development	An integrated site design methodology that uses small-scale detention and retention (Integrated Management Practices, or IMPs) to replicate pre-existing site hydrological conditions.
Maximum Extent Practicable (MEP)	Standard, established by the 1987 amendments to the Clean Water Act, for the implementation of municipal stormwater pollution prevention programs (also see). See Chapter Two.
National Pollutant Discharge Elimination System (NPDES)	As part of the 1972 Clean Water Act, Congress established the NPDES permitting system to regulate the discharge of pollutants from municipal sanitary sewers and industries. The NPDES was expanded in 1987 to incorporate permits for stormwater discharges as well.

Nomograph
A chart that aids engineering calculations by representing the relationship among three variables. Nomographs in the California BMP Handbooks represent the relationship among percent annual capture, watershed imperviousness, and unit water quality volume.

Numeric Criteria
Sizing requirements for stormwater treatment BMPs established in Provision C.3.d. of the RWQCB's stormwater NPDES permit.

Operation and Maintenance (O&M)
Refers to requirements in the Stormwater NPDES Permit to inspect treatment BMPs and implement preventative and corrective maintenance in perpetuity. See Chapter Six.

Permeable Pavements
Pavements for roadways, sidewalks, or plazas that are designed to infiltrate runoff, including pervious concrete, pervious asphalt, unit-pavers-on-sand, and crushed gravel.

Percentile Rainfall Intensity
A method of determining design rainfall intensity. Storms occurring over a long period are ranked by rainfall intensity. The storm corresponding to a given percentile yields the design rainfall intensity.

Planned Unit Development (PUD)
Allows land to be developed in a manner that does not conform to existing zoning requirements. Allows greater flexibility and innovation because the PUD is regulated as one unit rather than each component lot being regulated separately.

Rational Method
A method of calculating runoff flows based on rainfall intensity, and tributary area, and a factor representating the proportion of rainfall that runs off.

Regional (or Watershed) Stormwater Treatment Facility
A facility that treats runoff from more than one project or parcel. Participation in a regional facility may be in lieu of on-site treatment controls, subject to the requirements of NPDES permit provision C.3.g.

Regional Water Quality Control Board (RWQCB)
California RWQCBs are responsible for implementing pollution control provisions of the Clean Water Act and California Water Code within their jurisdiction. There are nine California RWQCBs. Western and central Contra Costa County are under the jurisdiction of the RWQCB for the San Francisco Bay Region; eastern Contra Costa County is under the jurisdiction of the RWQCB for the Central Valley Region.

Retention
The practice of holding stormwater in ponds or basins and allowing it to slowly infiltrate to groundwater. Some portion will evaporate. See infiltration and detention.

Self-retaining area
An area designed to retain runoff from the design storm. Self-retaining areas may include graded depressions with landscaping or pervious pavements and may also include tributary impervious areas up to a 2:1 impervious-to-pervious ratio.

Stormwater Control Plan — A plan specifying and documenting permanent site features and BMPs that are designed to control pollutants for the life of the project.

Stormwater Control Operation & Maintenance Plan — A plan detailing operation and maintenance requirements for stormwater treatment BMPs incorporated into a project. An acceptable Stormwater Control Operation and Maintenance Plan must be submitted before the building permit is made final and a Certificate of Occupancy is issued.

Stormwater NPDES Permit — A permit issued by a Regional Water Quality Control Board (see) to local government agencies (Dischargers) placing provisions on allowable discharges of municipal stormwater to waters of the state.

Storm Water Pollution Prevention Plan (SWPPP) — A plan providing for temporary measures to control sediment and other pollutants during construction.

Stormwater Pollution Prevention Program — A comprehensive program of activities designed to minimize the quantity of pollutants entering storm drains. See Chapter One.

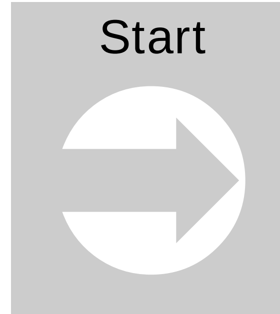
Storm Water Quality Task Force (SWQTF) — Publisher of the 1993 California Storm Water BMP Handbooks. See California Association of Stormwater Quality Agencies (CASQA).

Volume-based BMPs — Stormwater Treatment BMPs that detain runoff and treat it primarily through settling or infiltration.

WEF Method — A method for determining the minimum design volume of treatment BMPs, recommended by the Water Environment Federation and American Society of Civil Engineers. Described in *Urban Runoff Quality Management* (WEF/ASCE, 1998).

Water Board — See Regional Water Quality Control Board.

Water Quality Volume (WQV) — For stormwater treatment BMPs that depend on detention to work, the volume of water that must be detained to achieve maximum extent practicable pollutant removal. This volume of water must be detained for a specified drawdown time.



How to Use this Guidebook

Read the Overview to get a general understanding of the requirements. Then follow the step-by-step instructions to prepare your Stormwater Control Plan.

THIS *Guidebook* will help you ensure that your project complies with the California Regional Water Quality Control Boards' C.3 requirements. The requirements are complex and technical, and most applicants will require the assistance of a qualified civil engineer, architect, or landscape architect. Because every project is different, you should begin by scheduling a pre-application meeting with municipal planning staff. At this meeting, you can ask how the C.3 requirements, and other planning and zoning requirements, apply to your project.

ICON KEY
☞ Helpful Tip
Submittal Requirement
Terms to Look Up
References & Resources

To use the *Guidebook,* start by reviewing Chapter One, which provides a brief overview and explanation of the new requirements to control runoff from new development projects. The overview covers regulations, the plan review process, design issues, and the environmental benefits the regulations are intended to achieve.

If there are terms and issues you find puzzling, try finding answers in the glossary or in Chapter Two. Chapter Two consists of one-page summaries of key concepts like "maximum extent practicable," "imperviousness," and "design storm."

Then proceed to Chapter Three and follow the step-by-step guidance to prepare a Stormwater Control Plan for your site.

If your project requires CEQA review, Chapter Four will tell you how to integrate analysis of stormwater impacts and mitigations into your documentation.

Design requirements are provided in Chapter Five, along with references that will aid you in designing the features you've identified in your Stormwater Control Plan. Chapter Five also includes schematic designs and a simplified procedure for sizing stormwater treatment and hydrograph modification BMPs.

Chapter Six describes the agreements—dedication of fee or easement, a maintenance agreement that "runs with the land," or other long-term commitment—to provide for operation and maintenance of stormwater treatment facilities in perpetuity. Chapter Six also outlines maintenance requirements for some recommended treatment and hydrograph modification management devices.

Chapter Seven discusses some options you may have for alternative (off-site) compliance with the Regional Water Quality Control Boards' C.3 requirements.

Local Requirements
Cities, towns, or the County may have requirements that differ from, or are in addition to, this county-wide Guidebook. See Appendix A for local requirements.

Throughout each Chapter, you'll find references and resources to help you understand the regulations, complete your Stormwater Control Plan, and design stormwater control measures into your project. Your local planning and community development department will have copies of most of these references and resources.

The most recent, updated version of the *Guidebook* is on the Contra Costa Clean Water Program website at www.cccleanwater.org/construction/nd.php. The on-line *Guidebook* is in Adobe Acrobat format. If you are reading the Acrobat version on a computer with an internet connection, you can use hyperlinks to navigate the document and to access various references. The hyperlinks are throughout the document, as well as in "References and Resources" sections (marked by the 🕮 icon) and in the bibliography. Some of these links (URLs) may become outdated. In that case, you might try entering portions of the title or other relevant keywords into an internet search engine.

Chapter 1

Overview

For a broad-based understanding, look at the Stormwater C.3 requirements from four different perspectives: as water-quality regulations, as planning requirements, as a design challenge, and as a way to obtain environmental benefits for the community.

State and Federal Regulatory Perspective

The California Regional Water Quality Control Boards for the San Francisco Bay Region and Central Valley Region (RWQCBs) have mandated that Contra Costa municipalities impose new, more stringent requirements to control runoff from development projects.

The RWQCBs added Provision C.3 to the municipalities' stormwater NPDES permit in February 2003. The municipalities are phasing in the requirements from 2004 through 2006.

The RWQCBs have determined that the new Provision C.3 requirements are needed to implement Federal Clean Water Act provisions governing discharges to municipal storm drains.

Clean Water Act
Regulations on stormwater discharges have grown progressively more stringent since the Clean Water Act was amended in 1987.

Congress adopted amendments to the Clean Water Act in 1987, and the United States Environmental Protection Agency (USEPA) issued implementing regulations in 1990. The San Francisco Bay RWQCB began issuing stormwater discharge permits to municipalities that same year.

Since the early 1990s, Contra Costa municipalities have required contractors to implement temporary Best Management Practices (BMPs) to minimize the amount of sediment and other pollutants that enter site runoff during construction. For several years, the municipalities have also encouraged applicants to design their projects to minimize new impervious area and to incorporate into their plans permanent treatment BMPs – features and devices that detain, retain, or treat runoff for the life of the project.

"Maximum Extent Practicable"
For more on this and other stormwater terms, see the Glossary and discussions in Chapter Two.

As before, the standard for these BMPs is "maximum extent practicable," or MEP. However, the new permit requirements define MEP more specifically and include design criteria.

The new development provisions are one part of a comprehensive stormwater pollution prevention program implemented by each Contra Costa municipality. Those programs also require:

- Controls on runoff from existing commercial and industrial sites.
- Temporary measures to control sediment and other pollutants in runoff from construction sites.
- Changes in the way the municipalities maintain streets, parks and public infrastructure.
- Prevention of illegal dumping in storm drains.
- Public outreach and education.

Under the RWQCBs' stormwater discharge permits, cities, towns, and the County implement some activities individually. Other activities are done jointly through the Contra Costa Clean Water Program (CCCWP).

RWQCB staff monitors each municipality's implementation of permit requirements. Each municipality must report on its development review process, number and type of projects reviewed, and what runoff control measures were included in the projects.

ICON KEY

- Helpful Tip
- Submittal Requirement
- Terms to Look Up
- References & Resources

As required by Permit Provision C.3.f., the CCCWP is preparing a Hydrograph Modification Management Plan (HMP). The purpose of the HMP is to manage post-project runoff so that it does not exceed pre-project rates or durations if such an increase could contribute to downstream erosion. The HMP will provide instructions on how to determine whether a project might increase the amount and duration of runoff and provide guidance on how to design a site and incorporate BMPs so that post-project runoff flow and volume will not exceed pre-project rates or durations. As an alternative, project proponents may demonstrate that the risk of erosion due to increased runoff is minimal or may propose in-stream measures to control erosion.

While the HMP is being completed, project applicants are encouraged to use "dual-purpose" designs. These designs control pollutants and reduce runoff quantities by minimizing imperviousness and by slowing, retaining, and detaining runoff flows. The design approach recommended in Chapter Five achieves dual purposes by distributing small detention areas throughout the site, reducing overall runoff and increasing the time it takes for runoff to reach storm drains.

References and Resources

- San Francisco Bay RWQCB Order No. R2-2003-0022 (Stormwater NPDES Permit C.3 Amendment)
- San Francisco Bay RWQCB Order 99-058 (Stormwater NPDES Permit)
- Central Valley RWQCB Order 5-00-120 (Stormwater NPDES Permit covering Antioch, Brentwood, and Oakley and eastern portions of unincorporated Contra Costa County)
- RWQCB Fact Sheet on New Development Provisions
- RWQCB Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan)
- RWQCB Water Quality Control Plan for the Central Valley Region (Basin Plan)
- Clean Water Act Section 402(p)
- 40 CFR 122.26(d)(2)(iv)(A)(2) – Stormwater Regulations for New Development
- CCCWP – Stormwater Management Plan (1999-2004)
- CCCWP Hydrograph Modification Management Plan Literature Review and Work Plan

Local Development Review Perspective

The Contra Costa Clean Water Program created this Guidebook to help project applicants implement the stormwater C.3 requirements. The C.3 requirements are the same in all Contra Costa municipalities; however, specific procedures and application requirements may differ somewhat from one municipality to the next. The staff of each municipality aims to make the complex C.3 requirements clear and easy to follow. Municipal staff will work with project applicants to facilitate timely and complete review of their projects.

Local Requirements
Review Appendix A for information on local planning procedures and application requirements.

► THRESHOLDS

For previously undeveloped sites, and for project applications "deemed complete" after February 15, 2005, the C.3 requirements apply if a project creates one acre or more impervious area. On August 15, 2006, this threshold is reduced to 10,000 square feet of impervious area.[*]

Threshold
A Stormwater Control Plan will be required for projects that create more than one acre of new impervious area.

For sites that have been previously developed, the threshold is more complex.

- If the new project results in an increase of, or replacement of, 50% or more of the previously existing impervious surface, and the existing

[*] Water Board staff has stated that projects creating less than one acre impervious area will not be subject to Provision C.3.f (Hydrograph Modification Management Plan) requirements.

development was not subject to stormwater treatment measures, then the entire project must be included in the treatment measure design.

- If less than 50% of the previously impervious surface is to be affected, only that portion must be included in the treatment measure design.

Interior remodels, routine maintenance or repair, roof or exterior surface replacement, and repaving are not subject to C.3 requirements.†

► DEVELOPMENT REVIEW PROCESS

The process for reviewing stormwater controls is integrated with the municipalities' development review process. A simplified diagram of a typical development review process is shown in Figure 1-1.

If the C.3 requirements apply, planning staff will require that a Stormwater Control Plan be submitted along with the Planning and Zoning application. This should be discussed at the pre-application meeting.

CEQA

See Chapter Four for a discussion of how to document stormwater impacts and mitigations in Initial Studies and Environmental Impact Reports.

If the project requires review under the California Environmental Quality Act (CEQA), planning staff will require submittal of an Environmental Information Form. This submittal should document potential impacts of the project's changes to stormwater runoff. Typically, staff will use an initial study checklist to determine whether the project may still have significant effects on the environment after proposed mitigation measures are included. Stormwater impacts can be mitigated by minimizing site imperviousness, controlling pollutant sources, and incorporating treatment BMPs that retain, detain, or treat runoff.

This *C.3 Guidebook* will assist you to prepare a stormwater control plan for your project. Staff will use the checklist in Chapter 3 to determine if the stormwater control plan portion of your application is complete. Once the application is deemed complete, staff will use the *Guidebook* to determine whether the stormwater control plan complies with the RWQCBs' C.3 requirements.

Planning staff or the Planning Commission (or in some cases, a City Council or the County Board of Supervisors) will approve or deny the application. If the application is approved, staff, the commission, or the Council or Board will attach conditions of approval, including a requirement that you implement your stormwater control plan. A typical standard condition of approval mandating stormwater control plan implementation is in Appendix B.

† This summary is for information only. For application to a specific project, consult the RWQCB Order and discuss with City staff.

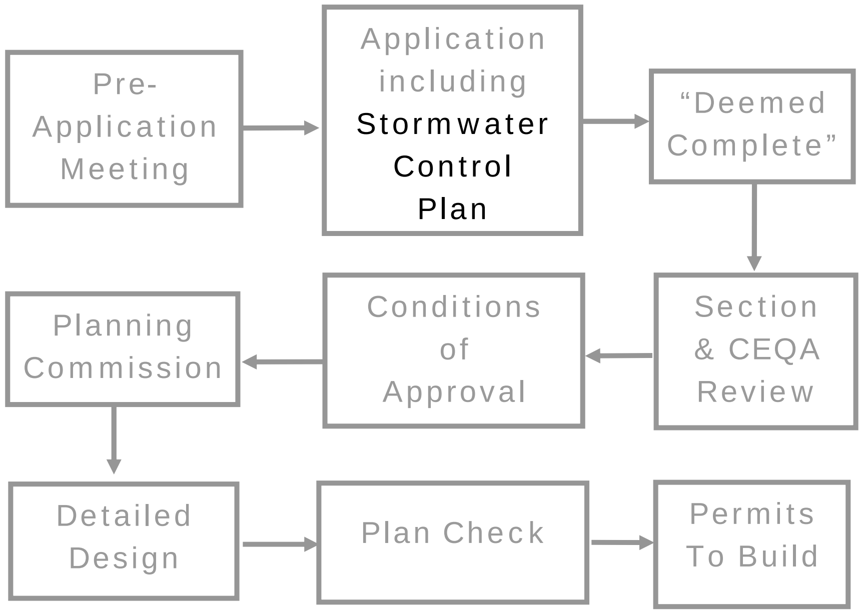


FIGURE 1-1. REVIEW OF THE STORMWATER CONTROL PLAN is integrated with the municipal development review process.

Following approval of your planning and zoning application, you may submit your application for building permits. City staff will check that the features and devices specified in the Stormwater Control Plan are incorporated into the construction plans, that the stormwater controls meet specified design criteria, and that their construction will comply with applicable building codes. A stormwater treatment control operation and maintenance plan (described in Chapter 6) must be submitted and approved before the building permit can be made final and a certificate of occupancy issued.

Prepare the stormwater control plan simultaneously with the preliminary site plan and landscaping plan.

Doing so will:

- Maximize multiple benefits of site landscaping.
- Reduce overall project costs.
- Improve site aesthetics and produce a better quality project.
- Be more likely to achieve "maximum extent practicable."
- Speed project review.
- Avoid unnecessary redesign.

A Stormwater Control Plan is a separate document from the Storm Water Pollution Prevention Plan (SWPPP). The SWPPP provides for temporary measures to control sediment and other pollutants during construction at sites that disturb one acre or more. The Stormwater Control Plan specifies permanent controls that should last for the life of the project. In some cases, the two plans need to be coordinated. For example, at the end of the construction phase, a basin used for temporary sediment control could be converted to a permanent swale, basin, or bioretention area. The basin would be shown in both plans.

Preparing a Stormwater Control Plan involves the following steps:

1. Assemble needed information.
2. Identify constraints and opportunities.
3. Design to minimize imperviousness.
4. Compare pre- and post-project runoff hydrographs.
5. Locate and select treatment and hydrograph modification management BMPs.
6. Perform preliminary design of BMPs.
7. Specify source controls.
8. Integrate with other preliminary drawings.
9. Identify permitting and code compliance issues.
10. Identify BMP maintenance requirements.
11. Complete a Stormwater Control Plan & Report.

Chapter Three helps guide you through each step. Chapter Four includes information on how to document stormwater potential impacts and mitigations in CEQA documentation.

References and Resources:

- RWQCB Order No. R2-2003-0022 (Stormwater NPDES Permit Amendments) Provisions C.3.(b) and C.3.(j)
- California Planning and Zoning Law
- California Environmental Quality Act
- *CEQA Deskbook 1999 [Second] Edition* (Bass, Herson, and Bogdan, Solano Press Books, 2001)
- California Building Code
- *California Stormwater Best Management Practice Handbook (Construction)*
- *Manual of Standards for Erosion and Sediment Control Measures* (Association of Bay Area Governments, 1986)

TABLE 1-1. A SWPPP and a Stormwater Control Plan are two separate documents.

	Storm Water Pollution Prevention Plan (SWPPP)	*Stormwater Control Plan*
Primary objective	Minimize potential runoff pollution during construction.	Minimize potential runoff pollution for the life of the project.
Pollutants targeted	Sediment from erosion and site disturbance, maintenance of construction equipment, construction activities (e.g. painting).	Pollutants deposited in airborne dust, liquids and dust from automobiles, cleaning solutions (e.g. from food service), litter and trash.
Coordination with review process	Submitted with application for building permit.	Submitted with application for planning and zoning review.
Coordination with project planning	Coordinated with grading plans and construction scheduling and phasing.	Integrated with site plan, drainage plan, and landscaping.

Planning and Design Perspective

In most cases, stormwater controls will add to the overall cost of a project. Stormwater controls may also constrain use of the site.

However, if executed well, and if integrated with landscaping and site amenities, stormwater controls can add to your project's quality and value.

From a site design perspective, the aim of stormwater controls is to make site drainage mimic, as much as possible, the way a natural landscape drains.

Much of the rain falling on a natural landscape is held by vegetation, soaks into the soil, or seeps slowly downhill. Pollutants washed out from the atmosphere are absorbed through contact with soils and vegetation.

Roofs and paving prevent rain from reaching the soil. Pollutants wash off the impervious surfaces, and drain pipes transport the runoff rapidly and efficiently to creeks or the Bay. Higher peak flows and runoff volumes may promote channel erosion—unless streambanks are hardened.

Because small storms make up most of total rainfall—and because small storms have cumulative and profound effects on stream channel stability—it makes sense

Because small storms make up most of total rainfall—and because small storms have cumulative and profound effects on stream channel stability—it makes sense to design stormwater treatment controls to detain, retain, and treat runoff from small storms. Consistently throughout the U.S., 80% or more of average annual total rainfall comes in storms of less than one inch rainfall depth.

An obvious, and effective, way to limit site runoff is to minimize the amount of pavement and roofs. Some paved areas can be designed with unit pavers, gravel, or other pervious surfaces. Runoff from small paved areas, like sidewalk or driveway strips, can be sloped to drain to concave lawns or landscaping.

Runoff collected from larger impervious areas, like roofs or parking lots, can be channeled through features located in depressions and integrated into the landscape. These features include swales, infiltration/detention basins, and bioretention areas.

These treatment BMPs can help infiltrate runoff into the soil. If soils are impermeable or groundwater is too close to the surface—as in parts of Contra Costa County—the features can detain and treat runoff before it is allowed to slowly drain away.

Where space and site layout do not allow swales, basins, or bioretention areas, it is still possible to use vaults for storage and sand filters for treatment. These devices work, but are more expensive, require more maintenance, do not contribute to site aesthetics, and (if not carefully maintained) can provide breeding habitat for mosquitoes.

Projects in the Bay Area, throughout the U.S., and in other countries have successfully implemented these techniques. Design manuals are available to guide architects and engineers through the design process, including the selection of options, sizing, and specifications.

Chapter Five provides guidance on design requirements.

References and Resources

- *Start at the Source* (BASMAA, 1999)
- California Best Management Practice Handbooks (CASQA, 2003).
- Urban Runoff Quality Management (WEF/ASCE, 1998)
- Low Impact Development Design Strategies: An Integrated Approach (Maryland, 2001)
- Site Planning for Urban Stream Protection (Scheuler, 1995)
- *Urban Small Sites Best Management Practice Manual* Barr Engineering for Metropolitan Council of Governments (Minneapolis/St. Paul)

Environmental Benefit Perspective

The diverse natural geography of Contra Costa County includes tidal and freshwater wetlands, alluvial plains, and mountain slopes. Annual rainfall varies from 12.5 inches in Brentwood to 30 inches in Orinda.

The climate, soils, slope, and vegetation give each Contra Costa stream a characteristic structure of riffles, pools, terraces, floodplains, and wetlands. In relatively undisturbed stream reaches, this geomorphic structure supports trees and other riparian vegetation. Trees provide shade (cooling stream temperatures), create root wads and undercut banks (refuge for fish) and produce falling leaves and detritus (the bottom of a food web). Fish, frogs, and other animals have evolved to thrive in riparian habitats. Because Contra Costa habitats are diverse and complex, some species are specialized, have limited ranges, and may be rare.

Contra Costa's landscape, like that of all the San Francisco Bay Area, has been repeatedly transformed since the Spanish arrived in the 1770s. Even before the area was developed, European grasses, weeds, and other plants replaced much of the native vegetation. Creek flows were diverted to irrigate farms and wetlands were diked or filled for farmland.

Suburbs and former farm towns developed rapidly during and after the Second World War. In many places, to make flood-prone land suitable for development, creeks were channelized or confined within levees. Buildings, streets, and pavement now cover much of the land, and storm drains pipe runoff from urban neighborhoods directly into the creeks. Urbanization has changed the timing and intensity of stream flows and has set off a chain of unanticipated consequences. These consequences include more frequent flooding, destabilized stream banks, armoring of streambanks with riprap and concrete, loss of streamside trees and vegetation, and the destruction of stream habitat.

The remaining habitat, even where it has been disturbed and reduced to remnants, is an important refuge for various species. The U.S. and California have listed some of these species, including steelhead (*Oncorhyncus mykiss),* as endangered. Other species are listed as threatened, rare, or having other special status.

Once altered, natural streams and their ecosystems cannot be fully restored. However, it is possible to stop, and partially reverse, the trend of declining habitat and preserve some ecosystem values for the benefit of future generations.

This is an enormous, long-term effort. Managing runoff from a single development site may seem inconsequential, but by changing the way most sites are developed (and redeveloped), we may be able to preserve and enhance existing stream ecosystems in urban and urbanizing areas.

References and Resources

- *Restoring Streams in Cities* (Riley, 1998)
- *Stream Restoration: Principles, Processes, and Practices*
  (Federal Interagency Stream Restoration Working Group, 1998)
- *Contra Costa County Watershed Atlas* (Contra Costa County, 2003)

Chapter

2

Stormwater Concepts

All about BMPs, MEP, imperviousness, etc.

Like practitioners in any other specialized field, planners and engineers working on stormwater control have created their own lingo. Within the array of acronyms and shorthand, there are several key concepts—some of them based on water-quality regulations, others on evolved design practice—that are indispensable to communication between project proponents, designers, and reviewers.

The glossary at the front of this Guidebook lists words and concepts that can be explained adequately in a sentence or two. Other concepts require elaboration, including an explanation of how they apply to designing and permitting development projects.

This chapter explains the following key concepts:

- Maximum Extent Practicable
- Best Management Practices
- Imperviousness
- Design Storm

Maximum Extent Practicable

As required by the Clean Water Act, the RWQCB limits the allowable concentration (and sometimes the allowable load) of pollutants in municipal and industrial sewage discharged to State waters.

When it amended the Clean Water Act in 1987, Congress recognized that it was not technically feasible to establish similar limits on pollutants in stormwater discharged from municipal storm drains. Instead, Clean Water Act Section 402(p)(3)(iii) says that each state:

> …shall require controls to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and system, design and engineering methods, and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants.

"Maximum extent practicable" is not defined in Federal law or regulation.

CCCWP's Stormwater Management Plan incorporates continuous improvement to ensure that the pollution-prevention efforts consistently achieve "maximum extent practicable." Under the stormwater discharge permit, CCCWP updates performance standards that establish, for various elements of the stormwater pollution prevention program, the level of effort that currently corresponds to "maximum extent practicable."

When reviewing proposed development projects, municipal staff uses current performance standards and best professional judgment to determine whether proposed stormwater controls meet the "maximum extent practicable."

As knowledge of stormwater control develops, it is becoming more common for "maximum extent practicable" to be expressed as numeric criteria. For example, the 2003 amendments to the stormwater permit established numeric standards for sizing stormwater treatment BMPs. Municipal staff must apply these standards when reviewing proposed development projects.

For other aspects of site design and treatment BMP design, municipal staff may consult available design manuals and apply their engineering or other professional judgment.

Best Management Practices

Clean Water Act Section 402(p) and USEPA regulations (40 CFR 122.26) specify a municipal program of "management practices" to control stormwater pollutants. Best Management Practice (BMP) refers to any kind of procedure or device designed to minimize the quantity of pollutants that enter the storm drain system.

Since the adoption of the regulations in 1990, a rough taxonomy of BMPs has emerged. As shown in Table 2-1, BMPs can be classified three ways:

A. *Manifestation*. Structural BMPs are built devices or site features (e.g., a constructed wetland). Operational BMPs are practices or procedures (e.g., dumping washwater in an indoor sink rather than the gutter, or sweeping outside work areas daily).

B. *Longevity*. Permanent BMPs are structural BMPs intended to last the life of the project (e.g. a constructed wetland). Temporary BMPs (e.g. silt fences) are removed when construction is finished.

C. *Mode*. Source control BMPs (or source control measures) aim to stop pollutants from entering stormwater. All operational BMPs are for source control, but source control BMPs can also be permanent structural BMPs (e.g., a berm around a dumpster area). Treatment BMPs are features or devices that remove pollutants that have already become suspended or dissolved in stormwater.

TABLE 2-1. BMPs classified three ways.

A. Manifestation	*B. Longevity*	*C. Mode*
Structural	Permanent	Source Control
Operational	Temporary	Treatment

As described in Chapter Three and Chapter Five, there are two approaches to incorporating treatment BMPs into new development sites. Treatment BMPs can be integrated into the landscape design and distributed throughout the site (Integrated Management Practices, or IMPs), or site drainage can be piped to a larger, engineered conventional treatment BMP. Many IMPs are flow-based BMPs—they treat runoff by filtering it continuously through soil. Detention basins, the most common type of conventional treatment BMP, are an example of a volume-based BMP. Volume-based BMPs treat stormwater primarily through settling or infiltration.

Commercial and industrial facilities must implement operational BMPs to the maximum extent practicable, and residents are expected to avoid allowing anything other than stormwater (e.g., soapy water, paint, litter) from entering storm drains. These requirements are implemented and enforced by other parts of municipal comprehensive stormwater pollution prevention programs.

Imperviousness

Schueler (1995) proposed imperviousness as a "unifying theme" for the efforts of planners, engineers, landscape architects, scientists, and local officials concerned with urban watershed protection. Schueler argued (1) that imperviousness is a useful indicator linking urban land development to the degradation of aquatic ecosystems, and (2) imperviousness can be quantified, managed, and controlled during land development.

Imperviousness has long been understood as the key variable in urban hydrology. Peak runoff flow and total runoff volume from small urban catchments is usually calculated as a function of the ratio of impervious area to total area (rational method). The ratio correlates to the runoff factor, usually designated "C". Increased flows resulting from urban development tend to increase the frequency of small-scale flooding downstream.

Imperviousness links urban land development to degradation of aquatic ecosystems in two principal ways.

First, the combination of paved surfaces and piped runoff efficiently collects urban pollutants and transports them, in suspended or dissolved form, to surface waters. These pollutants may originate as airborne dust, be washed from the atmosphere during rains, or may be generated by automobiles and outdoor work activities.

Second, increased peak flows and runoff durations typically cause erosion of stream banks and beds, transport of fine sediments, and disruption of aquatic habitat. Measures taken to control stream erosion, such as hardening banks with riprap or concrete, may permanently eliminate habitat. By reducing groundwater infiltration, imperviousness may also reduce dry-weather stream flows.

Imperviousness has two major components: rooftops and transportation (including streets, highways, and parking areas). The transportation component is usually larger and is more likely to be directly connected to the storm drain system.

The effects of imperviousness can be mitigated by disconnecting impervious areas from the drainage system and by making drainage less efficient—i.e., by encouraging detention and retention of runoff near the point where it is generated. Detention and retention reduce peak flows and volumes and allow pollutants to settle out or adhere to soils before they can be transported downstream.

Design Storm

No two rainstorms are exactly alike. Hydrologists sort and analyze rain gauge records to find long-term patterns of rainfall intensity and duration. Then they predict runoff flows and volumes based on these patterns and on the size, slopes, soils, land uses, and drainage patterns of a particular watershed.

Engineers select a design storm to calculate the required size of facilities that convey, store, or treat runoff. Because small storms occur many times a year, and larger storms come once in many years, the design storm is selected based on probability (e.g., the allowable likelihood that a channel will overflow in any given year). Often, applicable regulations specify the rainfall intensity and duration that must be used in design.

Different design storms apply to different purposes. Selection of a design storm balances costs and benefits. Roof leaders and flood control channels are typically designed to convey runoff from a storm with a one-in-one-hundred (1%) probability of occurring in any particular year (commonly called the "one-hundred-year storm"). Flood control detention basins may be designed to hold a storm predicted to occur, on average, in 4% or 10% of the coming years (a 25-year or 10-year storm, respectively).

NPDES permit Provision C.3.d includes criteria for designing treatment BMPs. These criteria target treatment of 80% of average annual runoff. (See the discussion of maximum extent practicable on page 14.) Because a large portion of average annual runoff is produced by small storms that occur many times a year, treatment BMPs can be designed to bypass larger storms. The 80% criterion means that BMPs will be bypassed, on average, every 1-2 years.

Because treatment BMPs are designed to treat only small storms, they can be considerably smaller than detention basins designed to protect property during flood-generating storms that may recur in 10%, 4%, or 1% of coming years. However, treatment BMPs must be designed as part of an overall drainage system that can accommodate larger storms.

Development sites subject to NPDES permit Provision C.3.f will be required to maintain runoff peak flows and durations that existed prior to development, if increased flows or durations could cause downstream erosion. CCCWP's Hydrograph Modification Management Plan (HMP) will identify the method that must be used to compute pre- and post-development peak flows and durations. It is possible to design "dual-purpose" BMPs that infiltrate or detain stormwater flows and also remove stormwater pollutants.

Chapter

3

Preparing Your Stormwater Control Plan

Step-by-step assistance for site design and BMP selection.

Begin by scheduling a pre-application meeting with municipal planning staff to identify and discuss specific requirements that may apply to your project. Prepare your Stormwater Control Plan for submittal along with the other items specified by planning staff.

► OBJECTIVES.

Your Stormwater Control Plan must demonstrate that your project will incorporate site design characteristics, landscape features, and BMPs that will minimize imperviousness, retain or detain stormwater, slow runoff rates, and reduce pollutants in post-development runoff to the maximum extent practicable. Additional requirements may apply if runoff from your site discharges directly to creeks or wetlands. (See Order R2-2003-0022, Provision C.3.b.ii).

A complete and thorough Stormwater Control Plan will enable planning staff to verify that your project complies with these requirements. Every Contra Costa municipality requires a Stormwater Control Plan for every applicable project so that municipal staff can document their compliance with the RWQCB permits.

ICON KEY
Helpful Tip
Submittal Requirement
Terms to Look Up
References & Resources

► CONTENTS.

Your Stormwater Control Plan will consist of a plan and a report. Staff will use the following checklist to evaluate the completeness of your Plan.

STORMWATER CONTROL PLAN CHECKLIST

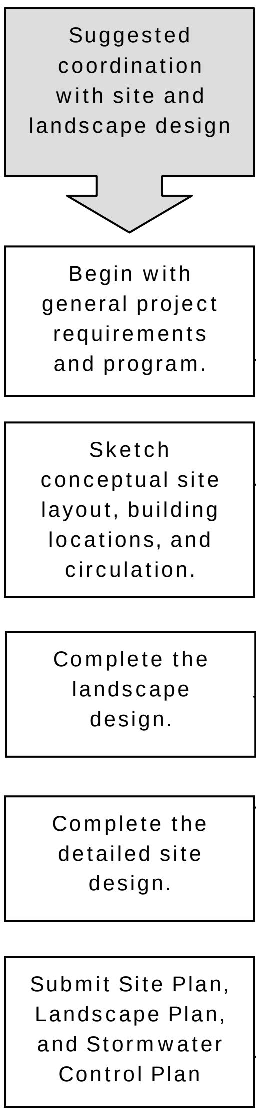
Required	Adequate	CONTENTS OF PLAN
		Show on drawings:
❒	❒	Existing natural hydrologic features (depressions, watercourses, relatively undisturbed areas) and significant natural resources. (Step 1 in the following step-by-step instructions)
❒	❒	Soil types and depth to groundwater (if infiltration is proposed). See Appendix C. (Step 1)
❒	❒	Existing and proposed site drainage network and connections to drainage off-site. (Step 3)
❒	❒	Proposed design features and surface treatments used to minimize imperviousness. (Steps 3 and 4)
❒	❒	Separate drainage areas, depending on complexity of drainage network. (Steps 3, 4, and 5)
❒	❒	Existing condition of each drainage area, including pervious and impervious areas. (Steps 3, 4, and 5)
❒	❒	For each drainage area, types of impervious area (roof, plaza/sidewalk, and streets/parking) and area of each. (Steps 3, 4, and 5)
❒	❒	Proposed locations and approximate sizes of infiltration, treatment, or hydrograph modification BMPs. (Steps 4 and 5)
❒	❒	Pollutant source areas, including loading docks, food service areas, refuse areas, outdoor processes and storage, vehicle cleaning, repair or maintenance, fuel dispensing, equipment washing, etc., and corresponding required source controls from Appendix E. (Step 6)

Required	Adequate	CONTENTS OF REPORT
		A report accompanying the drawings should include:
❒	❒	Narrative analysis or description of site features and conditions that constrain, or provide opportunities for, stormwater control. (Step 2)
❒	❒	Narrative description of site design characteristics that protect natural resources. (Step 3)
❒	❒	Narrative description and/or tabulation of site design characteristics, building features, and pavement selections that reduce imperviousness of the site. (Step 3)
❒	❒	Tabulation of pervious and impervious area, showing self-retaining areas and areas tributary to each infiltration, treatment, or hydrograph modification BMP. (Steps 3, 4, and 5)
❒	❒	Preliminary designs, including calculations, for each treatment or hydrograph modification management BMP. Elevations should show sufficient hydraulic head for each. (Step 5)
❒	❒	A table of identified pollutant source areas and for each, the source control measure(s) used to reduce pollutants to the maximum extent practicable. See worksheet in Appendix E. (Step 6)
❒	❒	Identification of any conflicts with codes or requirements or other anticipated obstacles to implementing the Stormwater Control Plan (Step 8).
❒	❒	General description of maintenance needs for treatment/hydrograph modification BMPs (Step 9)
❒	❒	Means by which BMP maintenance will be financed and implemented in perpetuity. (Step 9)
❒	❒	Statement accepting responsibility for interim operation & maintenance of treatment BMPs (Step 9).
❒	❒	Construction Plan C.3 Checklist (Step 10).
❒	❒	Certification by a civil engineer, architect, and landscape architect (Step 10).

Step by Step

The Clean Water Program recommends that you plan and design your stormwater controls integrally with the site planning and landscaping for your project. It's best to start with general project requirements and preliminary site design concepts; then prepare the detailed site design, landscape design, and stormwater control plan simultaneously.

Even if a site design has already been prepared, you can still incorporate adequate stormwater controls. However, because you'll be working within the constraints of the design, you may be limited to selecting more expensive, higher-maintenance, and less aesthetically pleasing stormwater treatment options.



The following step-by-step procedure should optimize your design by identifying the best opportunities for stormwater controls early in the design process. Regardless of which design procedure you use, you should still review this chapter for explanation of expectations and requirements for your Stormwater Control Plan.

The recommended steps are:

1. Assemble needed information.
2. Identify site opportunities and constraints.
3. Design to minimize imperviousness.
4. Locate and select treatment/hydrograph modification BMPs.
5. Perform preliminary design of treatment/hydrograph modification BMPs.
6. Specify source controls.
7. Integrate the Stormwater Control Plan with site and landscape plans.
8. Identify permitting and code compliance issues.
9. Identify BMP maintenance requirements.
10. Complete the Stormwater Control Plan.

Step 1: Assemble Needed Information

To select types and locations of BMPs, the designer needs to know the following site characteristics:

- Existing natural hydrologic features and natural resources, including any contiguous natural areas, wetlands, watercourses, seeps, or springs.
- Existing site topography, including contours of any slopes of 4% or steeper, general direction of surface drainage, local high or low points or depressions, any outcrops or other significant geologic features.
- Zoning, including requirements for setbacks and open space.
- Soil types (including hydrologic soil groups) and depth to groundwater, which may determine whether infiltration is a feasible option for managing site runoff. A preliminary determination of infiltration feasibility may be made using maps and criteria in Appendix C. As discussed there, depending on site location and characteristics, site-specific information (e.g. from boring logs or geotechnical studies) may be required.
- Existing site drainage. For undeveloped sites, this should be obtained by inspecting the site and examining topographic maps and survey data. For previously developed sites, site drainage and connection to the municipal storm drain system can be located from site inspection, municipal storm drain maps, and plans for previous development.
- Existing vegetative cover and impervious areas, if any.

References and Resources

- Appendix C, Stormwater Infiltration Guidelines
- *Start at the Source* (BASMAA 1999), p. 36
- USDA NRCS Technical Release TR55 Documentation—Appendix A: Soil Types

Step 2: Identify Constraints & Opportunities

Review the information collected in Step 1. Identify the principal constraints on site design and BMP selection as well as opportunities to reduce imperviousness and incorporate BMPs into the site and landscape design. For example, **constraints** might include impermeable soils, high groundwater, groundwater pollution or contaminated soils, steep slopes, geotechnical instability, high-intensity land use, heavy pedestrian or vehicular traffic, or safety concerns. **Opportunities** might include existing natural areas, low areas, oddly configured or otherwise unbuildable parcels, easements and landscape amenities including open space and buffers (which can double as locations for BMPs), and differences in elevation (which can provide hydraulic head for BMPs).

Prepare a brief **narrative** describing site opportunities and constraints. In the review process, this narrative may help establish the **maximum extent practicable** degree of stormwater control required for your site.

Step 3: Design to Minimize Imperviousness

► OPTIMIZE THE SITE LAYOUT

To minimize stormwater-related impacts, apply the following design principles to the layout of newly developed and redeveloped sites:

- Define development envelope and protected areas, identifying areas that are most suitable for development and areas that should be left undisturbed.
- Set back development from creeks, wetlands, and riparian habitats.
- Preserve significant trees.
- Avoid erodible soils and steep slopes.

Where possible, conform the site layout along natural landforms, avoid excessive grading and disturbance of vegetation and soils, and replicate the site's natural drainage patterns. Concentrate development on portions of the site with less permeable soils, and preserve areas that can promote infiltration.

► LIMIT PAVING AND ROOFS

For all types of development, **limit overall coverage** of paving and roofs. This can be accomplished by designing compact, taller structures, narrower and shorter streets and sidewalks, smaller parking lots (fewer stalls, smaller stalls, and more efficient lanes), and indoor or underground parking. Examine site layout and circulation patterns and identify areas where landscaping or planter boxes can be substituted for pavement.

► MINIMIZE DIRECTLY CONNECTED IMPERVIOUS AREA

With the built and landscaped areas defined on a site drawing, look for opportunities to minimize directly connected impervious area:

- Direct runoff from impervious areas to adjacent pervious areas or depressed landscaped areas. A 2:1 ratio of impervious to pervious area is generally acceptable where soils permit (except in hillside areas). As discussed in Chapter 5, much higher ratios (up to 25:1) can be used with an appropriately designed landscape infiltration/bioretention BMP, which may require a subsurface liner and/or drainage.

- Select permeable pavements and surface treatments. Inventory paved areas on the preliminary site plan and identify locations where permeable pavements, such as crushed aggregate, turf block, or unit pavers can be substituted for impervious concrete or asphalt paving.

► DETAIN AND RETAIN RUNOFF THROUGHOUT THE SITE

- Use drainage as a design element. Use drainage swales, depressed landscape areas, vegetated buffers, and bioretention areas as amenities and focal points within the site and landscape design. In some cases, swales can be placed alongside roadways to convey and treat stormwater runoff.

- Minimize peak flow and volume of runoff. Design landscaped areas and incorporate Integrated Management Practices (IMPs, Steps 4 and 5) to detain or retain runoff to the maximum extent practicable.

► DOCUMENT YOUR DESIGN DECISIONS

Chapter Five describes how to document pervious and impervious areas within your project and how to quantify the benefits achieved by your design decisions to reduce paved and roofed areas, to create self-retaining landscaped areas and pervious pavements, and to direct runoff from impervious to pervious areas.

Chapter Five also includes instructions for using the provided spreadsheet to create a table of pervious areas within your site.

To accompany the table, prepare a brief narrative that documents the site layout and site design decisions you made that minimize imperviousness, retain or detain stormwater, slow runoff rates, and reduce pollutants in post-development runoff to the maximum extent practicable.

References and Resources

- *Start at the Source* (BASMAA, 1999).
- Your municipality's *General Plan*
- Your municipality's Zoning Ordinance and Development Codes
- *Low Impact Development Manual* (Maryland, 1999).
- *Site Planning for Urban Stream Protection* (Schueler, 1995b).

Step 4: Select Treatment BMPs

In Step 3, you minimized the total quantity of runoff by reducing impervious area and directing some runoff to pervious areas. You also sketched the site's drainage system, divided the site into drainage areas, and tabulated pervious areas.

In this step, inventory and tabulate impervious areas and identify appropriate locations for facilities (BMPs) that will retain, or detain and treat, runoff before it flows offsite. Then select the appropriate BMPs. The opportunities and constraints identified earlier (in Step 2) will help guide this process.

There is no hard-and-fast procedure or set of rules for selecting treatment and hydrograph modification management BMPs. Selection is ultimately by the designer's professional judgment and preference, but the suite of BMPs selected must meet the criteria set in the RWQCB permit.

A first consideration in identifying a drainage and treatment strategy is to decide whether infiltration to groundwater is a practical option for the site. In general, the cheapest and most effective treatment BMPs are adequately sized areas, designed into site landscaping, that will infiltrate design flows to groundwater. In sites with space constraints, infiltration can be promoted by using surface infiltration basins, subsurface trenches or dry wells.

Infiltration to groundwater may not be used where:

- The infiltration BMP would receive drainage from areas where chemicals are used or stored, where vehicles or equipment are washed, or where refuse or wastes are handled.
- Surface soils are polluted.
- The BMP could receive sediment-laden runoff from disturbed areas or unstable slopes.
- Soils are insufficiently permeable to allow the BMP to drain within 72 hours.

Infiltration BMPs may also be infeasible because of steep slopes, geotechnical instability, high groundwater, low-permeability soils, or a combination of these factors.

Special restrictions apply to the following infiltration devices that, as designed, may bypass filtration through surface soils before reaching groundwater:

- Infiltration basins.
- Infiltration trenches (includes french drains).
- Unlined retention basins (i.e., basins with no outlets.
- Unlined or open-bottomed vaults or boxes installed below grade (includes bubble ups and permeable pavement with underground storage).

These restrictions are detailed in Appendix C.

On sites where infiltration is not feasible, BMPs will use detention and treatment, rather than infiltration to groundwater, to manage runoff.

Treatment is accomplished by either detaining runoff long enough for pollutants to settle out or by filtering runoff through sand or soil. Typically, the limiting design factors will be available space and available head (difference in water surface elevation between inflow and outflow). In some cases, a small adjustment of elevations within the site plan can make a treatment option feasible and cost-effective.

ICON KEY

- Helpful Tip
- Submittal Requirement
- Terms to Look Up
- References & Resources

A second consideration in developing a drainage and treatment strategy is whether to route most or all drainage through a single detention and treatment BMP or to disperse smaller BMPs (IMPs) throughout the site. Piping runoff to a single treatment area may be simpler and easier to design, but designs that integrate IMPs such as swales, small landscaped areas, and planter boxes throughout the site are typically more cost-effective, easier to maintain, and more aesthetically pleasing.

► GUIDANCE FOR SELECTING BMPS

Appendix C includes fact sheets for widely applicable IMPs that can be integrated into site landscaping and distributed throughout the site.

Low Impact Development Strategies: An Integrated Design Approach (Prince George's County, Maryland, Department of Environmental Resources, 1999) guides the designer through the Low Impact Development (LID) approach to stormwater control, which emphasizes small, cost-effective, widely distributed landscape features (**Integrated Management Practices, or IMPs**) rather than larger facilities located at the bottom of drainage areas.

Urban Runoff Quality Management (Water Environment Federation Manual of Practice No. 23; American Society of Civil Engineers Manual and Report on Engineering Practice No. 87) focuses on larger, **conventional BMPs**. For areas with less permeable soils (Hydrologic Soil Groups C & D), and where nutrients are not a major concern, the WEF/ASCE manual recommends extended detention, ponds with permanent pools, constructed wetlands, or media filtration.

One approach or the other may be best for a particular site, or elements of both approaches may be combined. In addition to the WEF/ASCE Manual and Low Impact Development manual, the City of Portland's *Stormwater Manual* (revised 2002) includes many design details for treatment BMPs.

Links to additional manuals and design resources can be found on the Contra Costa Clean Water Program's website. Local agencies may also have available manuals and other design guides for your reference. These manuals and guides should be used as a starting point for selection and design of treatment BMPs that meet the RWQCB requirements and local codes. Keep in mind that the criteria and recommendations in these manuals may be different, or inapplicable, to projects in specific municipalities or locations.

The overall design for the site must meet RWQCB requirements, local planning and zoning requirements, and applicable building codes.

The designs must also be maintainable. Maintenance requirements for BMPs must be identified in the Stormwater Control Plan. (See Step 10 and Chapter 6.) A detailed **Stormwater BMP Maintenance Plan** will be required at the time of application for a Certificate of Occupancy.

► LOCATING TREATMENT BMPS ON YOUR SITE

Finding the right location for treatment and hydrograph modification management BMPs on your site involves a careful and creative integration of several factors:

- For effective, low-maintenance operation, **locate BMPs so drainage into and out of the device is by gravity flow**. Pumped systems can be feasible, but are expensive, require more maintenance, are prone to untimely failure, and can cause mosquito control problems. Most stormwater BMPs require a minimum 2-3 feet of head.

- **Consider final ownership and maintenance responsibility.** If the BMP will serve only one site owner, make sure it is located for ready access by inspectors from the local municipality and the Contra Costa Mosquito and Vector Control District. If the property is being subdivided now or in the future, the BMP should be in a common, accessible area. Dedication of title or easement providing ownership and/or access to your local agency may be required at the time of subdivision. In particular, avoid locating BMPs on private residential lots.

- The BMP must be accessible to equipment needed for its maintenance. Access requirements for maintenance will vary with the type of BMP selected. For example, planter boxes or biofiltration swales will typically need access for the same types of equipment used for landscape maintenance. Wet or dry detention ponds typically require maintenance roads that can be used by heavy vehicles for dredging and control of emergent vegetation. Vaults and underground filters may require special equipment for periodic clean out and media replacement. See Chapter Six for typical maintenance requirements for various types of BMPs.

- To make the most efficient use of the site and to maximize aesthetic value, integrate BMPs with site landscaping. Many local zoning codes may require landscape setbacks or buffers, or may specify that a minimum portion of the site be landscaped. It may be possible to locate some or all of your site's treatment and hydrograph modification BMPs within this same area.

References and Resources

- RWQCB R2-2003-0022, Provision C.3.d
- *Urban Runoff Quality Management* (WEF/ASCE, 1998).
- Low Impact Development Design Strategies: An Integrated Approach (Maryland, 1999)
- Site Planning for Urban Stream Protection (Scheuler, 1995)
- *Stormwater Manual* (City of Portland, 2002).
- *California Stormwater BMP Handbooks*
- *Minnesota Urban Small Sites BMP Manual* (Barr Engineering, 2001)

Step 5: Perform Preliminary Design of BMPs

Demonstrate the feasibility and effectiveness of the treatment BMPs you selected by showing that they meet the design criteria in Chapter Five. Detailed construction drawings are not required at this stage, but drawings or sketches should be included as needed to illustrate the proposed design and to support calculations.

Chapter Five also provides a method of accounting for pervious and impervious areas and for demonstrating that the suite of BMPs you choose is sufficient to meet the RWQCB permit requirements. The procedure includes the design of BMPs for stormwater treatment, followed by assessment and redesign, if necessary, to control the peaks and durations of stormwater flows. See page 50. The Contra Costa Clean Water Program recommends that you use this procedure in preparing your Stormwater Control Plan.

Step 6. Specify Source Control BMPs

Some everyday activities – such as trash recycling/disposal and washing vehicles and equipment – generate pollutants that tend to find their way into storm drains. These pollutants can be minimized by applying source control BMPs.

Source control BMPs include permanent, structural features that must be incorporated into your project plans and operational BMPs, such as regular sweeping and "housekeeping," that must be implemented by the site's occupant or user. The maximum extent practicable standard typically requires both types of BMPs. In general, operational BMPs cannot be substituted for a feasible and effective permanent BMP.

Use the following procedure to specify source control BMPs for your site:

► IDENTIFY POLLUTANT SOURCES

Review your preliminary site plan. Then review the first column in the Pollutant Sources/Source Control Checklist (Appendix E). Check off the potential sources of pollutants that apply to your site.

► NOTE LOCATIONS ON SITE PLAN

Note the corresponding requirements listed in Column 2 of the Pollutant Sources/Source Control Checklist (Appendix E). Incorporate these items into your Stormwater Control Plan drawings.

► PREPARE A TABLE AND NARRATIVE

Check off the corresponding requirements listed in Column 3 in the Pollutant Sources/Source Control Checklist (Appendix E). Now, create a table using the format in Table 3-1. In the left column, list each potential source on your site (from Appendix E, Column 1). In the middle column, list the corresponding permanent, structural BMPs (from Columns 2 and 3, Appendix E) used to prevent pollutants from entering runoff. Accompany this table with a narrative that explains any special features, materials, or methods of construction that will be used to implement these permanent, structural BMPs.

TABLE 3-1. Format for table of permanent and operational source control measures.

Potential source of runoff pollutants	*Permanent source control BMPs*	*Operational source control BMPs*

► IDENTIFY OPERATIONAL SOURCE CONTROL BMPS

To complete your table, refer once again to the Pollutant Sources/Source Control Checklist (Appendix E, Column 4). List in the right column of your table the operational BMPs that should be implemented as long as the anticipated activities continue at the site. The local stormwater ordinance requires that these BMPs be implemented; the same BMPs may also be required as a condition of a use permit or other revocable discretionary approval for use of the site.

References and Resources

- Appendix E, Stormwater Pollutant Sources/Source Control Checklist
- RWQCB Order R2-2003-0022, Provision C.3.k
- *Start at the Source*, Section 6.7: Details, Outdoor Work Areas
- *California Stormwater Industrial/Commercial Best Management Practice Handbook*
- *Urban Runoff Quality Management* (WEF/ASCE, 1998) Chapter 4: Source Controls

Step 7: Integrate With Other Preliminary Drawings

Depending on the complexity of the project, the Stormwater Control Plan drawing may be combined with the site plan, landscape plan, or drainage plan. In any case, the Stormwater Control Plan should be carefully coordinated with these plans, with site grading and drainage, and with construction-phase erosion and sediment control plans.

Local Requirements

Cities, towns, or the County may have requirements that differ from, or are in addition to, this countywide Guidebook. See Appendix A and check with local planning and community development staff.

Here are some typical considerations that may arise in coordinating stormwater control plans with other construction plans:

Excess fill. Excavation for landscape detention areas, swales, and other BMPs—and overexcavation/replacement of clay soils with more permeable soils—can alter the cut-and-fill balance for site grading and preparation. By considering this issue early in site design, it may be possible to avoid excessive export of soil from the site.

Compaction of soils during construction. Compaction from construction traffic can radically reduce the infiltration capacity of site soils. Construction staging plans should set aside and protect areas that will be used for self-retaining areas, infiltration, or IMPs.

Building Drainage. Building codes require that drainage from roofs and impervious areas be drained away from the building. The codes also specify minimum sizes and slopes for roof leaders and drain piping. Detailed designs of BMPs located in or on the building, or that may affect building foundations, must accommodate these codes while also meeting the minimum requirements for detention or flow stated in Provision C.3.

Control of elevations. Distribution of overland flow to landscaped areas may require that grading and landscape plans be executed with greater attention to slopes and elevations. Here are two typical problems to avoid:

- **Inadequate reveal** between pavement and vegetated areas. Provide adequate reveal (drop) at the edge of pavement to accommodate the growth of turf or other vegetation in an adjacent filter strip, swale, or landscape retention area. Otherwise, runoff will tend to pond on the edge of the paved surface.

- **Differential settlement.** The soil in filter strips, swales, and landscape retention areas must be left loose and uncompacted. However, concrete structures (e.g. inlets and outlets) must be supported on a firm foundation. Otherwise, they will tend to settle more than the surrounding ground, creating depressions which may harbor mosquito larvae.

Drainage Plans. The local building or engineering department may require a drainage plan when the project final design is submitted for plan check. In most cases, the drainage plan is designed to prevent street flooding during a 10-year storm and successfully route flows from a 100-year storm. To meet the requirements for both the Stormwater Control Plan design storm and the Drainage Plan design storm, BMP designs must incorporate bypasses or overflows to route excess flows to the storm drain system. It may be necessary to complete a preliminary drainage plan at the planning and zoning review stage.

Plant selection. Depressed landscaped areas, bioretention areas, vegetated swales, and many other BMPs require appropriate plant selection to work properly. Plant selection should be coordinated with or incorporated into the landscape plan. Local codes require landscaping to be designed for water

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conservation and may also encourage the use of native or other drought-tolerant plants. Some also require potable water not be used for irrigation where recycled water is available.

Access for periodic maintenance. All BMPs will require access for periodic inspection in accordance with an approved maintenance plan. Many BMPs (e.g., bioretention basins and swales) require relatively little maintenance, but others (e.g., sand filters or proprietary devices) may require regular replacement of surface sand or replacement of cartridges or inserts. Site plans should provide for the necessary access for personnel and equipment. If BMPs are to be maintained by a public agency, then a deeded access easement may be required. See Step 9.

Organizing traffic and parking. Your stormwater control plan may call for depressing landscaped areas below paved areas rather than setting them above paved areas and surrounding them with curbs. Striping or bollards may be needed to guide traffic. Parking lots with crushed aggregate, unit-paver, and other permeable pavements may also require bollards or signs to organize parking.

References and Resources

- Your Municipality's Municipal Code (See Appendix A)
- Your Municipality's Standard Engineering Drawings

Step 8: Permitting & Code Compliance Issues

To meet the RWQCB's "maximum extent practicable" standard, Stormwater Control Plans will typically need to incorporate innovative site design features, pavements, drainage design practices, and BMPs. Because these practices are new, there may be inconsistencies with existing building codes, engineering requirements, and standard conditions of approval.

The Clean Water Program makes no representation that the design practices or recommendations in this Guidebook (or in the publications listed as references and in the bibliography) meet existing applicable codes or standards.

Where conflicts occur between recommended stormwater control practices and existing codes and standards, municipal staff will work with the applicant to identify one or more regulatory or design solutions that can satisfy all applicable requirements.

Discuss potential conflicts with municipal planning staff you note in the Stormwater Control Plan. By doing so, it may be possible to resolve the issue prior to final design. This will help avoid the need for redesign and resubmittal of final plans and associated project delays.

Step 9: Plan for BMP Maintenance

As required by NPDES Permit Provision C.3.e, your local municipality will periodically verify that treatment BMPs on your site are maintained and continue to operate as designed.

To make this possible, your municipality will require:

1. That you specify, in your Stormwater Control Plan, a means to finance and implement BMP maintenance in perpetuity.

2. That you specify, in your Stormwater Control Plan, general maintenance requirements for the treatment and hydrograph modification BMPs you have selected.

3. That you prepare and submit, before applying for building permit final and Certificate of Occupancy, a detailed Stormwater BMP Operation and Maintenance Plan that sets forth a maintenance schedule for each of the treatment and hydrograph modification BMPs built on your site.

A summary of these requirements follows. See Chapter Six for additional detail.

► SPECIFY A MEANS TO FINANCE AND IMPLEMENT BMP MAINTENANCE

Your Stormwater Control Plan must specify a means to **finance and implement maintenance** of treatment and hydrograph modification BMPs **in perpetuity**.

Depending on the intended use of your site and the policies of your municipality, this may require one of the following:

- Dedication of fee title or easement transferring ownership of the BMP to the municipality.
- Execution of a maintenance agreement that "runs with the land."
- Application for a permit for the site owner to operate the BMP.
- Compliance with the conditions of a municipal ordinance.

Your municipal planner or other representative will help you determine which of these apply to your project and will specify what must be included in your Stormwater Control Plan.

► MAINTENANCE NEEDS AND YOUR STORMWATER CONTROL PLAN

Your Stormwater Control Plan should include a general description of anticipated BMP maintenance requirements. This will help ensure that:

- Ongoing costs of maintenance have been considered in your BMP selection and design.
- Site and landscaping plans provide for access for inspections and by maintenance equipment.
- Landscaping plans incorporate irrigation requirements for BMP plantings.
- Initial maintenance and replacement of BMP plantings is incorporated into landscaping contracts and guarantees.

Chapter Six includes a discussion of typical maintenance requirements for some commonly used BMPs.

Local Requirements

Cities, towns, or the County may have requirements that differ from, or are in addition to, this countywide Guidebook. See Appendix A and check with local planning and community development staff.

In your Stormwater Control Plan, you should also note issues or concerns, specific to your site or to a specific BMP installation, to be followed up during the detailed design and construction phases of your project. For example, it may be necessary to verify that weirs and flow spreaders remain level and that sediment and debris accumulated during construction does not fill depressions or clog inlets and outlets. These items to be verified post-construction should be included in the Stormwater Control Plan.

► STORMWATER CONTROL OPERATION AND MAINTENANCE PLAN

Your local municipality will require submittal of a draft Stormwater Control Operation and Maintenance Plan (O&M Plan) for the site with your building permit application. A final O&M Plan must be submitted prior to issuance of a certificate of occupancy. Instructions for preparing an O&M Plan are in Appendix F. Your O&M plan will list all treatment and hydrograph modification management BMPs on the site along with the required periodic maintenance.

Except for BMPs that are transferred to the public, the municipality will typically require an annual report to verify that maintenance has been done. The municipality will also require that the O&M Plan be kept on site. Municipal inspectors will refer to the O&M Plan during site visits.

Your O&M Plan must also include the project developer's signed statement accepting responsibility for maintenance from the time the BMPs are constructed until responsibility for operation and maintenance is legally transferred.

Step 10: Stormwater Control Plan & Report

Your Stormwater Control Plan Report should document the information gathered and decisions made in Steps 1-10. A clear, complete, well-organized report will make it possible to confirm that the "maximum extent practicable" standard has been applied in each aspect of the project design.

► SAMPLE OUTLINE AND CONTENTS

I. Project Setting

  A. Project Name, Location, Description

  B. Existing site features and conditions

  C. Opportunities and constraints for stormwater control

II. Measures to Limit Imperviousness

  A. Measures to cluster development and protect natural resources

  B. Measures used to limit directly connected impervious area

    (1) Site design features

    (2) Pervious pavements

    (3) Detention and drainage design

  C. Table summarizing pervious and self-retaining areas.

III. Selection and Preliminary Design of Treatment and Hydrograph Modification BMPs

  A. Locations and elevations

  B. Sizing calculations

  C. Table summarizing impervious areas and BMPs

IV. Source Control Measures

A. Description of site activities and potential sources of pollutants

B. Table showing sources and permanent controls

C. List of operational source control BMPs

V. Summary of Permitting and Code Compliance Issues

VI. BMP Maintenance Requirements

A. Ownership and responsibility for maintenance in perpetuity.

(1) Commitment to execute any necessary agreements.

(2) Statement accepting responsibility for operation and maintenance of BMPs until that responsibility is formally transferred.

B. Summary of maintenance requirements for each BMP.

VII. Construction Plan C.3 Checklist

VIII. Certification

► CONSTRUCTION PLAN C.3 CHECKLIST

When you submit construction plans for City review and approval, the plan checker will compare that submittal with your Stormwater Control Plan. By creating a Construction Plan C.3 Checklist for your project, you will facilitate the plan checker's comparison and speed review of your project.

TABLE 3-2. Format for Construction Plan C.3 Checklist.

Stormwater Control Plan Page #	*BMP Description*	*See Plan Sheet #s*

Here's how:

1. Create a table similar to Table 3-2. Number and list each measure or BMP you have specified in your Stormwater Control Plan in Columns 1 and 2 of the table. Leave Column 3 blank. Incorporate the table into your Stormwater Control Plan.

2. When you submit construction plans, **duplicate the table** (by photocopy or electronically). Now fill in Column 3, identifying the plan sheets where the BMPs are shown. List all plan sheets on which the BMP appears. Submit the updated table with your construction plans.

Note that the updated table—or Construction Plan C.3 Checklist—is **only a reference tool** to facilitate comparison of the construction plans to your Stormwater Control Plan. Planning Department staff can advise you regarding the process required to propose changes to the approved Stormwater Control Plan.

► CERTIFICATION

Your local municipality may require that your Stormwater Control Plan be certified by an architect, landscape architect, or civil engineer. See Appendix A. Certification should state: "The selection, sizing, and preliminary design of treatment BMPs and other control measures in this plan meet the requirements of Regional Water Quality Control Board Order R2-2003-0022."

► EXAMPLE STORMWATER CONTROL PLAN

Example Stormwater Control Plans are in Appendix G. Your Stormwater Control Plan will reflect the unique character of your own project and should meet the requirements identified in this *Guidebook*. Municipal staff can assist you to determine how specific requirements apply to your project.

Chapter 4

Stormwater Control & CEQA

Incorporating stormwater impacts and control measures into Initial Studies and Environmental Impact Reports

CEQA—the California Environmental Quality Act – requires local jurisdictions to identify and evaluate the environmental impacts of their actions, including zoning decisions and discretionary land-use approvals. The CEQA process makes decision makers and the public aware of potential adverse environmental impacts and prevents environmental damage by requiring implementation of feasible alternatives or mitigation measures.

Further guidance on the CEQA process is available from your local Planning or Community Development department and from the references and resources listed on page 44. This chapter clarifies how information in your Stormwater Control Plan may be used in the CEQA process.

The CEQA process is typically conducted in three phases:

1. Preliminary review to determine if the project is subject to CEQA.
2. Preparation of an Initial Study to determine the environmental effects of the project.*
3. Preparation of an Environmental Impact Report (EIR), Negative Declaration, or Mitigated Negative Declaration.

Your Stormwater Control Plan contains information to be reviewed during one or more of these phases of the CEQA process.

* The lead agency may choose to skip the Initial Study and proceed directly to an EIR.

Preliminary Review

CEQA review begins with a pre-application consultation at your local municipality's planning or community development department. At this meeting, a planner will help you identify specific issues that must be addressed in your application for planning and zoning approval.

If your project is subject to the C.3 Provisions—i.e., creates or replaces impervious area in excess of the applicable threshold—a complete Stormwater Control Plan should be part of this application.

By submitting a complete and adequate Stormwater Control Plan with your application for planning and zoning approval, you may be able to avoid further CEQA review for long-term (post-construction) stormwater impacts.

To determine if your project is also subject to CEQA, municipal planning staff will typically require that you complete an Environmental Information Form as part of your application for planning and zoning review. Depending on your project's scope, your municipality may require additional information and documentation.

Local Requirements

Check Appendix A now to see if your local municipality has specified procedures for CEQA review, and talk to a local planner before commencing work on CEQA or C.3 documentation.

If your project is not subject to CEQA—e.g., because of a statutory or categorical exemption—your local agency may choose to file a Notice of Exemption. Filing a notice reduces the length of time that the agency's decision is subject to challenge. Any C.3 requirements for your project will still apply.

If your project is not exempt from CEQA, planning or community development staff will complete an Environmental Checklist and Initial Study. Depending on the results of the Initial Study, the planner may recommend a Negative Declaration or Mitigated Negative Declaration be issued for the project, or recommend that an Environmental Impact Report be prepared.

Initial Study

NPDES permit provision C.3.m requires local municipalities to evaluate water quality effects and identify appropriate mitigation measures when they conduct environmental review of proposed projects.

The Governor's Office of Planning and Research (OPR) recommends that CEQA lead agencies should integrate CEQA review "to the fullest extent possible" with review for compliance with Federal, state, or local laws, regulations, or policies (*CEQA Guidelines* §15124(d)(1)(C)). In 1998, OPR revised the example Environmental Checklist Form (CEQA Guidelines Appendix G) to more closely align with Federal and state laws and requirements, including those of the state's Fish and Game Code, the Federal Clean Water Act, and the California Water Code. Most municipalities use the OPR Environmental Checklist Form or a variation thereof.

Questions on the Environmental Checklist Form connect potentially significant project impacts with water-quality regulations. For example:

- Question VIII.a asks: "Would the project violate any water quality standards or waste discharge requirements?"
- The potential effects of increased runoff peak flows and durations are addressed in question VIII.c: "Would the project substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation off-site?
- Potential impacts of runoff pollutants are targeted in Question VIII.e, which asks: "Would the project create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?"
- Finally, Question VIII.f. asks: "Would the project otherwise substantially degrade water quality?"

The C.3 provisions include suitable criteria for determining that a project could not contribute "substantial additional sources" of runoff or pollutants.

► THRESHOLDS OF SIGNIFICANCE

A threshold of significance is "a quantitative or qualitative standard, or set of criteria, pursuant to which the significance of an environmental effect may be determined." (OPR 1994). Thresholds are not rigid or absolute—the significance of an activity depends on its specific location—but they do help Lead Agencies make consistent and well-supported determinations.

In most cases, your local municipality will regard projects that exceed the threshold in NPDES permit provision C.3.c., defined therein as a "Group 1 project," to have potentially significant impacts (unless mitigated) due to increases in runoff pollutants over the life of the project.*

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* Construction-phase impacts should be addressed in a Storm Water Pollution Prevention Plan, which is required for projects that disturb an acre or more. See page 8.

This threshold is one acre of new impervious area for projects with applications deemed complete on February 15, 2005 or later, and 10,000 square feet of new impervious area for projects with applications deemed complete on August 15, 2006 or later. The threshold does not apply to projects for which the municipality has issued a waiver of the requirements for treatment BMPs as provided in NPDES permit Provision C.3.g. The CEQA threshold and C.3 requirements are intended to address both cumulative and site-specific increases in runoff pollutants due to imperviousness.

A project may also have potentially significant impacts due to increases in runoff pollutants if the facility includes outdoor storage of materials or wastes or if it accommodates outdoor activities such as automotive or equipment repair. Examples include car washes, grocery stores, some restaurants, and corporation yards. The threshold of significance in this case is qualitative and requires project-specific assessment of the potential for pollutants generated on-site to reach storm drains.

Increased site imperviousness may, by increasing the peaks and durations of runoff, potentially increase erosion of the beds and banks of downstream watercourses. In most cases, the threshold of significance for this impact is no increase in runoff peaks and durations, although there may be exceptions. The Contra Costa Clean Water Program's Hydrograph Modification Management Plan (HMP, Appendix D, to be completed in May 2005) specifies the methods for determining whether a project will increase runoff peaks and durations when compared against the existing condition of the site. In some cases, it may be possible to increase runoff peaks and durations without having a significant impact on erosion of downstream watercourses. The HMP specifies methods for determining whether this is the case for a particular site.

► FORMS AND CHECKLISTS

If a project is required to implement stormwater BMPs, the potential for significant stormwater impacts should be noted on the Environmental Information Form. If OPR's form (*CEQA Guidelines* Appendix H) is used, this is Question 26 (Change in ocean, bay, lake, stream, or ground water quality or quantity or alteration of existing drainage patterns). Reference the Stormwater Control Plan for the project when completing the Environmental Information Form.

If the Stormwater Control Plan for the project meets the criteria in NPDES permit C.3.d and incorporates recommended source control measures for each potential source of pollutants identified, then the relevant questions regarding stormwater quality in the Initial Study Checklist can, in most cases, be answered "less than significant with mitigation incorporation." The initial study should note the specific source control and treatment BMPs incorporated and reference the Stormwater Control Plan.

Negative Declaration or EIR

If the Initial Study finds that your project could have a significant environmental impact, a mitigated Negative Declaration or Environmental Impact Report must be prepared.

In general, the implementation of treatment BMPs that meet the numeric criteria in Provision C.3.d, as described in Chapter 5, will mitigate the effects of increased imperviousness on water quality to a level that is less than significant. Similarly, implementation of recommended source control BMPs for each identified source of potential pollutants will effectively mitigate the creation of these additional sources.

Methods for demonstrating that hydrograph modification BMPs mitigate potential increases in runoff peaks and durations are in the HMP (Appendix D).

The preparer of the EIR or other CEQA document may decide where and how to include detailed information from the Stormwater Control Plan—in the body of the CEQA document, as an appendix, or by reference.

Stormwater Impacts and the CEQA Process

In summary, municipalities may use the criteria in the C.3 provisions to specify thresholds of significance for stormwater impacts and also to identify and evaluate measures required to mitigate those impacts.

If the amount of impervious area created by a project is less than the threshold identified in NPDES permit provision C.3.c, and there are no significant new sources of runoff pollutants created by the project, then the relevant questions on the Initial Study Checklist can be answered "less than significant impact."

If the amount of impervious area created by a project exceeds the C.3.c threshold, and the project's Stormwater Control Plan incorporates the appropriate BMPs, a municipality may find that the project could not have a significant impact on stormwater quality.

Note that in some cases, a project may be below the impervious-area threshold in Provision C.3.c but could still create a significant new source of potential runoff pollutants. This might occur, for example, with an application for a use permit for a new business (say, a car wash) on an already fully developed (and impervious) site. In these cases, potential impacts can be mitigated through incorporation of appropriate permanent and operational source control BMPs.

Source control or treatment BMPs must be maintained for the life of the project to effectively mitigate the potential environmental effect. Similarly, operational

BMPs must be implemented thoroughly and consistently to be effective mitigations. Monitoring of permanent BMPs will be accomplished through the municipal BMP verification program (Chapter Six). The municipality also inspects industrial and commercial sites to verify consistent use of operational BMPs.

References and Resources

- California Environmental Quality Act Statutes (Public Resources Code §21000 *et seq.*)
- Governor's Office of Planning and Research— *CEQA Guidelines* (14 Cal. Code Regs.) and other resources.
- Environmental Information Form (*CEQA Guidelines* Appendix H)
- Environmental Impact Assessment Form (Initial Study Checklist—*CEQA Guidelines* Appendix G)
- CEQA Deskbook (Bass, et. al., 2001)

Chapter 5

Technical Requirements

Technical guidance for designing self-detaining areas and sizing treatment and hydrograph modification BMPs

Your Stormwater Control Plan (Chapter 3), to be submitted with your planning and zoning application, must show the locations, sizes, and types of treatment and hydrograph modification BMPs. Your Stormwater Control Plan must also include calculations showing:

- Your treatment BMPs meet the minimum sizing criteria in the stormwater NPDES permit.
- Your hydrograph modification BMPs meet the criteria in the Program's Hydrograph Modification Management Plan (HMP).

Your construction plans must be consistent with your approved Stormwater Control Plan. During plan check, local agency staff will also review the details of how your drainage and BMPs are constructed and will verify that they meet the requirements of the stormwater NPDES permit.

The Program has developed the following resources to help you design treatment and hydrograph modification BMPs for your project:

- "Fact sheets" for a gallery of practical and widely applicable BMPs. The fact sheets are in Appendix C and include illustrations, design checklists, and (for some BMPs) standard details.
- Simplified design methods. Some BMPs can be sized by simply multiplying the amount of impervious area draining to the BMP times a specified factor. The methods are described in this chapter.
- A procedure, described in this chapter, for tabulating pervious areas, impervious areas, and BMPs. The resulting tables make it easy to demonstrate compliance with the NPDES permit criteria.

This chapter has three parts.

The first part explains applicable technical criteria for sizing treatment BMPs, interprets the RWQCB's aims in establishing the criteria, and refers to the documents, studies, and rationales on which the criteria are based. This first part also provides some recommendations for selecting among the alternative sizing criteria allowed by the RWQCB. Finally, the first part summarizes the rationale for the HMP requirements.

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The second part of this chapter provides guidance for design and documentation of self-retaining areas and treatment and hydrograph-modification BMPs. A recommended design process maximizes the use of self-retaining areas and Integrated Management Practices (IMPs) while allowing choice and flexibility. The design process includes step-by-step completion of a table that can be submitted as part of your Stormwater Control Plan.

The third part of Chapter Five includes design tips and references to available design manuals.

Part 1: Stormwater Control Technical Criteria

The NPDES C.3. provisions require a complex, multifaceted approach to on-site stormwater control. In effect, project applicants must implement several different, independent measures to control stormwater pollutants, and each of these measures must independently meet a "maximum extent practicable" standard.

Specifically, applicants must:

- Control pollutant sources to the maximum extent practicable.
- Implement site design and landscape features which reduce runoff pollutants to the maximum extent practicable.
- Control increases in peak flows and durations to the maximum extent practicable.

Most measures of "maximum extent practicable" are qualitative and are based on professional judgment and current practices. However, the permit includes numeric criteria for the design of treatment BMPs. These numeric criteria are intended to ensure that the BMPs are adequately sized to remove a significant proportion of pollutants in runoff.

Permit Provision C.3.f requires limits on runoff peak flows, volumes, and durations. The Program's Hydrograph Modification Management Plan (HMP, to be completed in May 2005) will detail methods for demonstrating that the project design adequately manages runoff flows where increases in flows could accelerate erosion or otherwise affect beneficial uses of creeks.

Criteria for stormwater treatment and criteria for peak flow and volume of runoff are separate and independently applicable.

Your design of site drainage and BMPs must demonstrate that both sets of criteria are met.[*]

Note, in particular, that requirements for peak flow and volume control are dependent on the pre-development condition of your site. In contrast, the stormwater treatment criteria will be the same regardless of how or whether the site was previously developed.

► LIMITS ON THE USE OF DIRECT INFILTRATION

RWQCB permit Provision C.3.i. requires "treatment BMPs that function primarily as infiltration devices"—structures that are designed to infiltrate stormwater into the subsurface and, as designed, bypass the natural groundwater protection afforded by surface or near-surface soil—to have a 10-foot vertical separation from the "seasonal high groundwater mark." In addition, these BMPs should not serve work areas, including automotive shops, car washes, fleet storage, nurseries, or other areas that may be significant sources of pollutants.

In many areas of Contra Costa, high groundwater or impermeable soils preclude the use of infiltration. In other areas, steep slopes and geological instability make infiltration inadvisable. See Appendix C for guidance that will help you determine whether infiltration can be used for stormwater treatment or disposal on your site.

If infiltration is feasible, the design criteria and procedures in Appendix C will help you design infiltration devices that are appropriate for your site.

► NUMERIC CRITERIA FOR STORMWATER TREATMENT BMPS

The RWQCB permit assumes that treatment BMPs can be classified as relying either on detention and infiltration (e.g. detention basins, dry wells, or constructed wetlands) or on filtration (e.g., sand filters). The permit specifies volume-based criteria for those BMPs relying on infiltration and detention and flow-based criteria for BMPs relying on filtration.

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[*] Treatment control requirements apply to projects deemed complete on or after February 15, 2005. HMP requirements will take effect following RWQCB approval of the final plan, which is to be submitted by May 15, 2005.

► COMPARISON OF VOLUME-BASED NUMERIC CRITERIA

The RWQCB permit specifies two alternative methods for calculating **water quality volume**, the volume of water that must be detained for a BMP to meet the "maximum extent practicable" criterion. The first method is stated in the book *Urban Runoff Quality Management* (Water Environment Federation Manual of Practice No. 23; ASCE Manual and Report on Engineering Practice No. 87, 1998) and is referred to as the **WEF Method**. The second method is in Appendix D of the *California Storm Water Best Management Practice Handbook (Municipal)* (SWQTF, 1993) and is referred to as the **California BMP Method**.[*]

The two methods are based on the same rainfall data and hydrological methodology, and they tend to yield similar results. The methods differ in some aspects of their practical application.

Both methods use long-term rainfall records to identify a **design storm** for stormwater treatment. Approximately eighty percent of total annual runoff is produced by storms this size and smaller. The design storm for stormwater treatment varies from (roughly) 0.45 to 0.85 inches in Contra Costa County.

The WEF method requires that the designer specify a **drawdown time** of 12, 24, or 48 hours. Longer drawdown times require larger BMP volumes (because of the potential for back-to-back storms). Although the permit does not specify a drawdown time, the longer time (48 hours) has been recommended because sediments from the Bay Area's fine-grained soils require a relatively long time to settle out. The California BMP method uses a fixed drawdown time of 40 hours.[†]

The WEF method is based on 80% capture of average annual runoff. The California BMP Method allows the designer to select a capture ratio; however, the RWQCB permit specifies that an 80% capture ratio be used.

The WEF method requires estimation of a mean storm precipitation volume. This can be based on local rainfall data. The analysis is conducted by taking periodic (e.g. hourly) rain gauge data, identifying distinct storms, calculating the total rainfall depth of each, and taking an average. The California BMP method incorporates this analysis into a **nomograph** for the specific locality.

The WEF method requires calculation of a composite (weighted) runoff coefficient for the area that is tributary to the BMP being designed. The method provides a formula for calculating the runoff coefficient from the "watershed imperviousness ratio," or the percent total imperviousness.

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[*] The 2003 edition of the *California Storm Water Best Management Practices Handbook* (CASQA, 2003, available at www.cabmphandbooks.org) also describes this method, with some minor revisions.

[†] The 2003 revision to the California BMP Handbooks uses a drawdown time of 48 hours. A 48-hour drawdown time has been used in preparing the nomograph and sizing equations in Appendix H.

Similarly, the California BMP Method requires estimation of Directly Connected Impervious Area (DCIA), "the percentage of impervious area directly connected to the storm drain system. DCIA is defined as the area covered by pavement, building, and other impervious surfaces which drain directly into a storm drain without first flowing across pervious areas (e.g. lawns)." Conceptually, the tributary drainage is divided into areas that are either wholly pervious or wholly impervious.

► FLOW-BASED CRITERIA FOR TREATMENT BMPS

The RWQCB permit allows three alternatives for calculating the peak flow rate that a continuous-flow BMP (e.g., a sand filter without an upstream detention area) must be able to accommodate.

All three use the rational method to calculate peak flows:

$$Q = C\,i\,A$$

where

Q = Peak flow rate

C = Runoff coefficient (related to percent imperviousness)

i = Rainfall intensity

A = Tributary area

The difference between the three methods is in the calculation of the rainfall intensity, *i*.

The three alternatives are intensity-duration-frequency (IDF), percentile rainfall intensity, and 0.2 inches/hour.

The intensity-duration-frequency alternative requires that a time of concentration (T_c) be calculated for the tributary area. Calculation of a time of concentration is based on analysis of the time required for a hypothetical drop of water to flow from the furthest point of the watershed, overland and/or through pipes, to the BMP. Once T_c is determined, a corresponding *i* can be found from graphs of rainfall intensity vs. time from start of storm. The RWQCB permit specifies use of the rainfall intensity corresponding to a 50-year storm.

The percentile rainfall intensity alternative is based on ranking the hourly depth of rainfall from storms over a relatively long record. The RWQCB permit specifies that the design rainfall intensity be equal or greater than the 85th percentile hourly depth multiplied by two.

The 0.2 inches/hour alternative simply specifies the required i : 0.2 inches per hour. This is the recommended option.

In summary, if the designer uses either the percentile rainfall intensity alternative or the 0.2 inches/hour alternative to size a flow-based BMP, he or she need only specify the tributary area and its percent imperviousness.

If the intensity-duration-frequency method is used, the designer must calculate T_c. Because calculation of T_c is complex and uncertain, and because the peak flow rate can be sensitive to T_c, the Program discourages applicants from using this method. This method is most applicable to larger sites with overland drainage and relatively little impervious cover; however, the use of flow-based BMPs (such as sand filters) in such sites is not recommended because of the potential for clogging the filter with fine sediments.

► HYDROGRAPH MODIFICATION MANAGEMENT TECHNICAL CRITERIA

The objective of the HMP is that post-project runoff peaks and durations should not exceed pre-project runoff peaks and durations. In some cases, an increase may be allowed if it can be demonstrated that there is minimal risk of downstream erosion as a result of the increased runoff.

The Program's forthcoming HMP Guidance (Appendix D) will detail methods and criteria for:

- Characterizing and comparing pre- and post-project site hydrology.
- Predicting the effectiveness of hydrograph modification management BMPs.

References and Resources

- RWQCB Order R2-2003-0022, Provision C.3.d
- *California Stormwater Best Management Practice Handbooks* (SWQTF, 1993).
- *California Stormwater Best Management Practice Handbooks* (CASQA, 2003).
- *Urban Runoff Quality Management* (WEF/ASCE, 1998)
- *Hydrology Handbook, Second Edition* (ASCE, 1996)
- *Low Impact Development Design Strategies: An Integrated Approach* Chapter 3. (Maryland, 2001)

Part 2: Design and Documentation

There are two general approaches to managing site runoff.

The Low Impact Development approach emphasizes "disconnection" of impervious areas from the drainage system and detention, infiltration, and treatment of runoff throughout the site. Detention areas, infiltration areas, and Integrated Management Practices (IMPs), such as planter boxes, swales, and bioretention areas, are sized and shaped to fit the available space. Maintenance requirements may be little more than what is required for normal landscaping.

The conventional BMP approach emphasizes the design of fewer, larger facilities that can retain, detain, and treat runoff from large portions of the site or from the whole site. These BMPs typically serve a mix of impervious, pervious, and partially pervious areas and generally are more dependent on precise engineering and frequent maintenance. The WEF/ASCE Manual of Practice, *Urban Runoff Quality Management*, exemplifies the conventional BMP approach.

The two approaches are not exclusive and can be combined within a site.

In general, IMPs distributed throughout the site look better and can require less area. In addition, IMPs are less likely to fail and are less likely to harbor mosquitoes or other vectors. However, the Low Impact Development approach typically requires a more complex documentation of site drainage. Demonstrating compliance with C.3 requirements for stormwater treatment is somewhat more difficult with IMPs than with conventional BMPs. It is necessary to account for the impervious area treated by each IMP and show that each IMP has been appropriately sized.

Designs using IMPs are able to distribute runoff storage throughout the site. By incorporating small detention areas and IMPs into the flow path, these designs tend to increase the time of concentration of flow, reducing peak discharges and "flattening" the site hydrograph. However, the design and analysis of site drainage, and the preparation of site hydrographs, becomes more complicated.

The Program recommends the Low Impact Development approach. The following procedure has been developed to simplify (and make consistent) selection, sizing, and documentation of IMPs for stormwater treatment and hydrograph modification management.

► RECOMMENDED PROCEDURE FOR DESIGN AND DOCUMENTATION

The Program has developed the following recommended procedure for selecting and documenting self-retaining areas, IMPs, and conventional BMPs to achieve the mandated stormwater treatment criteria and to meet the requirements of the Program's hydrograph modification management plan.

The procedure maximizes the use of self-retaining areas and IMPs. It anticipates that, in many cases, conventional BMPs such as detention basins and media filters may not be necessary to achieve compliance with the C.3 provisions. Where conventional BMPs are required, the procedure minimizes their size.*

ICON KEY
Helpful Tip
Submittal Requirement
Terms to Look Up
References & Resources

The procedure requires careful delineation of pervious areas and impervious areas (including roofs) throughout the site. The procedure accounts for the runoff produced by each delineated area during the design storm. This simplifies design and arranges documentation of IMP sizing in a consistent format for presentation and review.

The recommended design procedure is intended to facilitate, not substitute for, creative interplay among site design, landscape design, and drainage design. Several iterations may be needed to find the combination of self-retaining areas, IMPs, and conventional BMPs that provides the optimal aesthetics, circulation, and use of available area for your site.

A spreadsheet template, in Microsoft Excel format, is provided for making calculations and presenting your submittal. See Appendix I. The spreadsheet can be copied into your Stormwater Control Plan.

To begin using the spreadsheet, first enter the project name, location, and Assessor's Parcel Number (APN). Then enter the total project area. Exclude areas of the site which will not be disturbed or developed.

Locate your project site on Figure B-166 (isohyetal map), which is in Appendix H. Interpolate as necessary to estimate the mean annual precipitation at your site and enter this number where indicated on the spreadsheet (at the top of Table 3). Note: this step is not required if all drainage from the site will be managed with self-retaining areas and indirect infiltration IMPs.

* The publication *Using Site Design Techniques to Meet Development Standards for Stormwater Quality, A Companion Document to Start at the Source* (BASMAA, May 2003, 14 pp. available at www.scvurppp.org) suggests using self-retaining areas to reduce the size of detention basins and other conventional BMPs. The approach described here maximizes self retaining areas first, then maximizes the use of IMPs, and incorporates conventional BMPs only as a last resort.

► DIVIDE THE SITE INTO DISCRETE DRAINAGE AREAS

While referring to preliminary roof plans and grading plans, divide the entire project area into discrete drainage areas. Minimize the concentration of runoff and amount of piping by distributing drainage from opposite sides of driveways, opposite sides of buildings, and from different sections of parking lots.

Assign each discrete area an identification number and determine its size (in square feet). Each area will be entered into Tables 1, 2, or 3 on the spreadsheet.

► IDENTIFY AND LIST PERVIOUS AND SELF-RETAINING AREAS

The required size of each treatment and hydrograph modification IMPs is proportional to the total amount of area draining to the IMP. The best way to reduce the number and size of treatment and hydrograph modification management IMPs is to disconnect portions of the tributary area and remove these disconnected areas from the sizing calculation.

Pervious areas, including turf, landscaped areas, and pervious pavements, may be disconnected by designing them to retain the design storm. In effect, this means that they must be designed to absorb the depth of the design storm before overflowing to the drainage system. Where possible, make all landscaped areas self-retaining, so that only impervious roofs and pavement drain to IMPs. This yields a simpler, more efficient design and also helps protects IMPs from becoming clogged by sediment.

Equivalence
Retaining the first inch of rainfall effectively disconnects an area from the drainage system for the purposes of the water-quality design storm.

To create self-retaining turf and landscape areas in flat areas or on terraced slopes, berm the area or depress the grade so that these areas will retain the required rainfall depth. Specify slopes, if any, toward the center of the pervious area. Drain inlets should be set above the low point to allow ponding. (Note: Landscape areas may also be appropriate locations for treatment and hydrograph modification BMPs.)

Self-retaining areas may include up to 2 parts impervious area for every 1 part pervious area. The drainage from the impervious area must be directed to and dispersed within the pervious area, and the pervious area must be designed to retain the design storm depth over the entire area. For example, for a 1-inch-deep design storm, and a ratio of 2 parts impervious and 1 part pervious, the pervious area must absorb 3 inches of

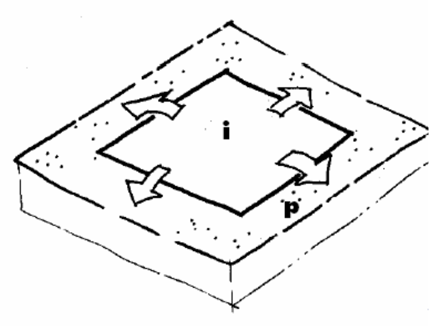

FIGURE 5-1. Relationship of impervious to pervious area for self-retaining areas: $p \geq \frac{1}{2} i$
From: Start at the Source.

water over its surface before overflowing. Prolonged ponding is a potential problem at higher impervious/ pervious ratios. In your design, ensure that the pervious area is designed to handle the additional run-on and is sufficiently well-drained. In flat areas with clayey soils, an underdrain system (perforated pipe embedded in an 8-to-12-inch layer of crushed rock and daylighted or connected to a storm drain) may be needed.

Areas covered with pervious pavement (e.g., crushed stone, pervious asphalt, or pervious concrete) can sometimes be handled similarly. Note that care must be taken to ensure that sediment from landscaped or undeveloped areas does not wash on to the pervious pavement and cause clogging.

Use Table 1 in the spreadsheet to document turf, landscape, pervious pavement, and other areas that are not completely impervious. Also use this table to list combined pervious/impervious self-retaining areas.

For non-self-retaining areas only, select the appropriate runoff factor "C" and enter it on the spreadsheet. (This factor will later be used to size conventional flow-based BMPs should they be proposed for your site.)

TABLE 5-1. ILLUSTRATION OF SPREADSHEET TABLE 1, for documenting pervious areas.

Area ID (as indicated on site drawing)	*Surfaces*	*Size (in SF) – Self-retaining areas*	*Size (in SF) – Non-self retaining areas*	*If non self-retaining, estimate runoff factor "C"*	*Size × C*
Total					

"C" factors (from BASMAA, 2003)

Turf	0.10	Pervious concrete	0.60
Landscape	0.10	Pervious asphalt	0.55
Crushed aggregate	0.10		

TABLE 5-2. ILLUSTRATION OF SPREADSHEET TABLE 2,
for documenting impervious areas and sizing planters, swales, and bioretention areas

Area ID (as indicated on site drawing)	*Description (e.g., roof, parking lot, driveway)*	*Size (in SF)*	*BMP ID# and type*	*Area Served by BMP*	*Sizing Factor*	*Minimum required BMP Surface Area*	*Surface Area as Designed*
Total							

Sizing Factors

Vegetated or Grassy Swale	0.04	Bioretention	0.04
Flow-through Planter	0.04	Infiltration Planter	0.04

► SIZING PLANTERS, SWALES, AND BIORETENTION AREAS

Runoff from **impervious areas** (roofs and impervious pavements) can be routed to planter boxes, swales, or bioretention areas, which use **indirect infiltration** and are integrated into the landscaping. Simple sizing factors may be used to size these IMPs.

Equivalence
The 0.04 sizing factor is applicable to BMPs that infiltrate runoff from rainfall of 0.2 inches per hour on 100% impervious area through soil or sand with a minimum infiltration rate of 5 inches per hour. (0.2/5 = 0.04).

To size swales, planters, and bioretention areas, follow this procedure:

1. Determine the impervious surface area that will drain to the IMP. (Only one IMP must be associated with each area listed. Two or more delineated areas may drain to the same IMP.)

2. Select an IMP type and apply the corresponding sizing factor to determine the required surface are of the IMP. (Currently, the sizing factor for all three of these IMPs is 0.04.)

3. Check that the required surface area can be accommodated within your site design, and redesign if necessary.

Enter the area of the IMP as designed. Design requirements and details for planters, swales, and bioretention areas are in Appendix C.

TABLE 5-3. ILLUSTRATION OF SPREADSHEET TABLE 3,
for documenting impervious areas and sizing infiltration basins, infiltration trenches, and dry wells

Area ID (as indicated on site drawing)	*Percent directly connected impervious area*	*Amount of Area (SF)*	*BMP ID# and type*	*Area Served by BMP*	*Required Water Quality Volume*	*Infiltration Rate (inches per hour)*	*Porosity of fill (Basin= 100%)*	*BMP Depth (feet)*	*Minimum required BMP Surface Area*	*Surface Area as Designed*
Total										

► SIZING INFILTRATION BASINS, INFILTRATION TRENCHES, AND DRY WELLS

Where native soils are in hydrologic soil groups "A" or "B" it may be possible to use direct infiltration IMPs such as infiltration basins, infiltration trenches, and dry wells. See Appendix C for help determining if direct infiltration is appropriate for your site.

Direct infiltration IMPs must meet two sizing criteria:

1. The detention volume must be equal to or greater than the required water quality volume.
2. The required bottom surface area depends on the infiltration rate and must be sufficient to ensure the IMP drains completely within 72 hours.

The spreadsheet calculates the required water quality volume using the California BMP method and local rainfall data (presented in Appendix H). Follow these steps:

1. First calculate the percent directly connected impervious area. The percent directly connected impervious area is simply the impervious area tributary to the IMP divided by the remaining total area tributary to the IMP. (Self-retaining areas are not included.) To avoid clogging, it is strongly preferred to drain only 100% impervious areas to direct-infiltration IMPs.

   The spreadsheet calculates the unit water quality volume using the formulae on the nomograph in Appendix H, performing any required interpolation for you.

The spreadsheet also multiplies the unit water quality volume times the area tributary to the IMP and displays the required water quality volume.

2. To determine the required surface area required for this water quality volume, begin by specifying a proposed working depth (i.e., from the bottom of storage to the height of overflow) of the basin or rock fill. For dry wells and infiltration trenches, the water quality volume must be divided by the porosity of the rock fill (normally 35%) to obtain the fill volume. For basins, enter 100%.

   The spreadsheet calculates the minimum required surface area based on the specified depth.

3. Next, enter the infiltration rate and confirm it is sufficient to drain the completely full IMP within 72 hours. Procedures for estimating or measuring the infiltration rate are in Appendix C and attachments.

► SIZING VOLUME-BASED CONVENTIONAL BMPS

If drainage from all impervious areas can be routed to adequately sized self-retaining areas or IMPs, then no conventional BMPs are required. However, if IMPs do not sufficiently retain, detain, and treat runoff flows, then conventional BMPs are necessary. (The self-retaining areas and IMPs will help minimize the required size of the conventional BMPs.)

The runoff from the remaining area in each catchment —pervious areas that are not self-retaining, plus impervious areas that are not completely served by IMPs—must be routed to a conventional BMP.

As described in the RWQCB permit, conventional BMPs are either volume-based or flow-based. For some volume-based conventional BMPs (e.g., detention basins and constructed wetlands) discharge is controlled by the size of the outlet orifice. Note that suitable outlet orifices cannot be designed for small flows; for this reason, these BMPs should only be used to treat large areas. Extended (dry) detention basins seem to work best and are least prone to problems when designed to serve areas of 20 acres or more.

The spreadsheet shows the remaining impervious area and total area not draining to IMPs, the percent DCIA of that area, and the resulting water quality volume for a conventional volume-based BMP such as an extended detention basin or wetland.

Note that if Tables 1, 2, and 3 are left blank (except for entering mean annual precipitation in Table 3), the spreadsheet shows the required water quality volume for a conventional extended detention basin or wetland.

► SIZING CONVENTIONAL FLOW-BASED BMPS

The spreadsheet calculates a composite "C" factor for areas not draining to IMPs, using information for "non-self-retaining" pervious areas in Table 1 and assuming a factor of 1.0 for impervious areas. The composite "C" factor is multiplied times the total area in square feet and a rainfall intensity of 0.2 inches/hour to obtain the design flow for a conventional flow-based BMP serving the entire site. The result is divided by 43,200 in-sec/ft-hr (converts the flow rate to cubic feet per second).

► HYDROGRAPH MODIFICATION MANAGEMENT IMPS

For projects subject to Provision C.3.f*, the next step is to check to determine if the project design—now including self-retaining areas and IMPs designed for stormwater treatment—will increase flow peaks and durations.

The Program's forthcoming Hydrograph Modification Management Plan (HMP, in Appendix D) will include step-by-step instructions (and spreadsheets or other tools) for comparing the site's hydrology in the pre-project and proposed project condition. An iterative procedure will make it possible to adjust the planned size of IMPs and to recheck results until an adequate design is obtained.

► CONVENTIONAL HYDROGRAPH MODIFICATION MANAGEMENT FACILITIES

Design of conventional detention facilities to control hydrograph modification typically involves:

1. Simulating pre- and post-project runoff from the project using continuous rainfall records.

2. Generating peak-recurrence and flow-duration curves from the results.

3. Designing a basin or other facility that generates a flow-duration curve that matches the pre-project flow-duration curve.

An iterative process is used to adjust storage and orifice sizes in the outlet structure. The outlet structure typically consists of a series of orifices at different elevations.

The HMP will include guidance for using a continuous runoff simulation model to evaluate site hydrology and design hydrograph modification management facilities.

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* Provision C.3.f will go into effect some time after May 15, 2005, and will apply to projects that create one acre or more impervious area.

References and Resources

- RWQCB Order R2-2003-0022, Provision C.3.d
- *Hydrology Handbook, Second Edition* (ASCE 1996)
- *Highway Design Manual* (California Department of Transportation, 2001). Chapter 8.
- *Portland Stormwater Management Manual* (City of Portland, 2002).
- *USDA SCS Technical Release TR55*, Appendix A: Soil Types

Part 3: Design Help

► SITE DESIGN AND SELF-RETAINING AREAS

Start at the Source: Design Guidance Manual for Stormwater Quality Protection, published in 1999 by the Bay Area Stormwater Management Agencies Association (BASMAA), is an updated version of a manual first published in 1997. The 1999 edition covers planning and zoning, site design, and drainage systems. The manual also includes some details for site design, pervious pavements and landscaping, and BMPs.

Start at the Source is an excellent general design guide and is best consulted at the beginning of the site design process.

► SELECTING AND DESIGNING IMPS

Attachment C-1 to Appendix C contains ten Infiltration Feasibility Fact Sheets covering site design practices, indirect infiltration practices, and direct infiltration practices.

The fact sheets include general information, illustrations, and design checklists as well as design details for some IMPs.

The fact sheets cover a wide range of options suitable for different site conditions and types of development in Contra Costa County. Consult Table 5-4 for an initial selection of options which may be suitable to your site.

TABLE 5-4. IDEAS FOR APPLYING IMPs
included in the Infiltration Feasibility Fact Sheets in Appendix C

Site Features and Design Objectives	*Green Roofs*	*Downspouts & Cisterns*	*Grading, Paving, & Land-scaping*	*Flow-through Planter*	*Infiltration Planter*	*Bio-retention Area*	*Vegetated or Grassy Swale*	*Infiltration Basin*	*Dry Well*	*Infiltration Trench*
Clayey native soils	✓	✓	✓	✓	✓	✓	✓			
Permeable native soils	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Very steep slopes	✓			✓						
Shallow groundwater	✓	✓	✓	✓	✓	✓	✓			
Avoid saturating subsurface soils	✓		✓	✓						
Connect to roof downspouts		✓		✓	✓				✓	
Parking lots/islands and medians			✓		✓	✓	✓			
Sites with extensive landscaping		✓	✓			✓	✓	✓		
Densely developed sites with limited space/landscape	✓		✓	✓	✓				✓	✓
Fit BMPs into landscape and setback areas		✓			✓	✓	✓			✓
Make drainage a design feature		✓	✓			✓	✓			
Convey as well as treat stormwater							✓			

The fact sheets are provided to assist you with developing a Stormwater Control Plan. Additional drawings and specifications, showing construction materials and methods to be used, plumbing connections, etc., may be required with your application for a building permit. Check with the local Building Department for requirements that apply to your project.

► DESIGN OF CONVENTIONAL BMPS

For guidance on designing constructed wetlands or detention basins, see *Urban Runoff Quality Management* (WEF/ASCE, 1998) and the *California Stormwater BMP Handbooks* (CASQA, 2003).

► MISCELLANEOUS CONSIDERATIONS FOR ENGINEERING BMPS

The following notes and design advice have been compiled from observations and experience with the design of BMPs for development sites and from the Program's Vector Control Plan. Review these notes and incorporate applicable items into your Stormwater Control Plan. This will help ensure that these concerns are addressed in the final design and construction permit review process.

Local Requirements
Cities, towns, or the County may have requirements that differ from, or are in addition to, this countywide Guidebook. See Appendix A and check with local planning and community development staff.

BMPs will require 1 to 4 feet or more **head** (difference in elevation between the inlet and outlet). Note that in some cases BMP outlets can be piped to underground storm drain systems. Wherever possible, locate and design the BMP along the hydraulic grade line of the site drainage. Vaults, pumps, and sumps are strongly discouraged because they reduce reliability, increase maintenance, and create potential vector problems.

To avoid **mosquito** problems, the California Department of Health Services recommends that dry basins (extended detention basins) should be designed to drain completely within **72 hours** of a rainfall. In many cases, it is acceptable in Contra Costa County to allow a maximum of five days for complete drainage.

Large, shallow basins with **gentle side slopes** are easiest to maintain and may be designed as multi-use facilities (e.g. playing fields or landscape). Design extended detention basins with a sloped bottom channel to promote complete drainage. Consider over-excavating and replacing the detention-basin bottom with permeable soil. Consider an underdrain to promote healthy turf and drainage.

Design and construct inlets and outlets to **avoid differential settlement** that can cause shallow, persistent puddles. Riprap or rock may be required to dissipate energy at inlets and outlets, but can collect standing water and create mosquito problems. Use cemented rock or ensure that any areas where water may temporarily pool are well-drained.

Underground vaults, deflection separators, oil/water separators, and drain inlet inserts are **discouraged**. Underground vaults typically lack the detention time required for removal of pollutants associated with fine particles. They also require frequent maintenance. Because vaults may be "out of sight, out of mind," experience shows that the required maintenance may not occur. If vaults are allowed they must be sealed against mosquito access and must also include suitable access doors and hatches to allow for frequent inspections and maintenance. The Water Board has stated that inlet inserts and oil/water separators are inadequate to meet the "maximum extent practicable" standard for stormwater treatment.

► OTHER DESIGN RESOURCES

Links to additional BMP design resources are on the Program's C.3 web page at www.cccleanwater.org/construction/nd.php.

References and Resources

- Contra Costa Clean Water Program *Vector Control Plan*.
- RWQCB Order R2-2003-0022, Provision C.3.d
- *Urban Runoff Quality Management* (WEF/ASCE, 1998).
- *Start at the Source* (BASMAA, 1999).
- *Low Impact Development Manual* (Prince Georges County, 1999).
- *Stormwater Manual* (City of Portland, 2002).
- *California Stormwater BMP Handbooks*
- *Storm Water Technology Fact Sheet: Bioretention* (EPA 832-F-99-012, 1999)
- *Minnesota Urban Small Sites BMP Manual* (Barr Engineering, 2001)
- *Stormwater Manual for Western Washington, Volume V* (Washington Dept. of Ecology, 2001)
- Bruce Wolfe, RWQCB, letter to Geoff Brosseau, BASMAA (August 5, 2004), "Use of Storm Drain Inlet Filters and Oil/Water Separators to Meet the Requirements of NPDES Municipal Stormwater Permits."
- "Application of Water-Quality Engineering Fundamentals to the Assessment of Stormwater Treatment Devices" (Salvia, 2000).

Chapter 6

BMP Maintenance

Identify the maintenance needs for the treatment BMPs on your site.

Treatment BMPs must be regularly maintained to ensure that they continue to be effective and that they do not cause flooding, harbor vectors, or otherwise cause a nuisance.

NPDES Permit Provision C.3.e requires Contra Costa municipalities to periodically verify operation and maintenance (O&M) of the treatment BMPs installed in their jurisdiction. Each year, they must report to the Water Board the treatment BMPs they have inspected that year and the status of each.

The treatment BMPs you install as part of your project will be incorporated into your municipality's operation and maintenance verification program. This is a six-stage process:

1. Determine who will own the BMP and be responsible for its maintenance in perpetuity.

2. Identify typical maintenance requirements, integrate these requirements into project planning and preliminary design, and document them in the Stormwater Control Plan. The Stormwater Control Plan must also identify any title transfers or maintenance agreements that will be executed before construction is complete.

3. Develop an Operation and Maintenance Plan for the site incorporating detailed requirements for each treatment BMP. This operation and maintenance plan must be submitted before the building permit is final and a certificate of occupancy is issued. With submittal of the operation and maintenance plan, execute any required agreements.

4. Maintain the treatment BMPs from completion of construction until ownership and maintenance responsibility is formally transferred.

5. Formally transfer operation and maintenance responsibility to the site owner or occupant.

6. Maintain the treatment BMPs in perpetuity and comply with your municipality's self-inspection, reporting, and verification requirements.

TABLE 6-1. SCHEDULE for planning operation and maintenance of stormwater treatment BMPs.

Step	*Description*	*Where documented*	*Schedule*
1	Determine BMP ownership and maintenance responsibility	Stormwater Control Plan	Discuss with planning staff at pre-application meeting
2	Identify general maintenance requirements	Stormwater Control Plan	Submit with planning & zoning application
3	Develop detailed operation and maintenance plan	BMP O&M Plan	Submit draft with Building Permit application; final due before applying for a Certificate of Occupancy
4	Interim operation and maintenance of BMPs	As required by municipal O&M verification program	During and following construction
5	Formal transfer of operation & maintenance responsibility	As required by municipal O&M verification program	On sale and transfer of property or permanent occupancy
6	Ongoing maintenance and compliance with inspection & reporting requirements	As required by municipal O&M verification program	In perpetuity

Step 1: Responsibility for BMP Maintenance

Ownership and maintenance responsibility for treatment BMPs should be discussed at the initial stages of project planning, typically at the pre-application meeting for planning and zoning review.

► PRIVATE OWNERSHIP AND MAINTENANCE

Typically, treatment (and hydrograph modification management) BMPs that serve a single commercial, industrial, multi-family residential, or multi-use parcel will be built on that parcel and will be maintained in perpetuity by the property owner.

The municipality may require a maintenance agreement to be executed, or a permit to operate the treatment BMP obtained, as a condition of project approval. In either case, the municipality may require an annual fee to offset the cost of inspecting the site to verify that the BMP is being maintained. Alternatively, the municipality may rely on its existing authorities (including its stormwater pollution prevention ordinance) to require ongoing maintenance of privately owned treatment BMPs.

The Program recommends that applicants and municipalities consider carefully the potential consequences of locating treatment BMPs on new private residential lots. This arrangement would require a municipality to verify that homeowners were maintaining their BMPs in perpetuity (and to take enforcement action if they have not been adequately maintained). The Program also recommends against maintenance of BMPs by homeowners associations or other private associations, because the private association may cease to exist at some point, while the municipality will always retain regulatory liability to ensure that the BMP is maintained. However, individual municipalities may find specific circumstances where private ownership and maintenance of BMPs in single-family residential areas is acceptable. On some lots it may be possible to use self-retaining areas (see page 53) instead of BMPs.

► TRANSFER TO PUBLIC OWNERSHIP

In subdivisions, municipalities may sometimes choose to have a treatment BMP deeded to the public in fee or as an easement. In that case, the municipality maintains the treatment BMP as part of the municipal storm drain system. The municipality may recoup the costs of maintenance through a special tax, assessment district, or similar mechanism.

Locating a treatment BMP in a public right-of-way or easement creates an additional constraint—along with hydraulic grade, aesthetics, landscaping, and circulation—to the location and design of BMPs. However, because sites typically drain toward the street, it may be possible to locate a swale or similar BMP parallel with the edge of the parcel. The swale may complement, or substitute for, an underground storm drain system.

Even if the treatment BMP is to be conveyed to the municipality after construction is complete, it is still the responsibility of the builder to identify general operation and maintenance requirements, prepare a detailed operation and maintenance plan, and to maintain the BMP until that responsibility is formally transferred.

Step 2: Typical Maintenance Requirements

Following are general maintenance requirements for typical treatment BMPs, including those featured in the fact sheets in Appendix C.

You can use this information to prepare your Stormwater Control Plan.

► SWALES AND BIORETENTION AREAS

These BMPs remove pollutants primarily by filtering runoff slowly through an active layer of soil. Routine maintenance is needed to ensure that flow is unobstructed, that erosion is prevented, and that soils are held together by plant roots and are biologically active. Typical maintenance consists of the following:

- Inspect inlets for channels, exposure of soils, or other evidence of erosion. Clear any obstructions and remove any accumulation of sediment. Examine rock or other material used as a splash pad and replenish if necessary.

- Inspect outlets for erosion or plugging.

- Inspect side slopes for evidence of instability or erosion and correct as necessary.

- Observe soil at the bottom of the swale or filter for uniform percolation throughout. If portions of the swale or filter do not drain within 48 hours after the end of a storm, the soil should be tilled and replanted. Remove any debris or accumulations of sediment.

- Confirm that check dams and flow spreaders are in place and level and that channelization within the swale or filter is effectively prevented.

- Examine the vegetation to ensure that it is healthy and dense enough to provide filtering and to protect soils from erosion. Replenish mulch as necessary, remove fallen leaves and debris, prune large shrubs or trees, and mow turf areas. When mowing, remove no more than ⅓ height of grasses. Confirm that irrigation is adequate and not excessive. Replace dead plants and remove noxious and invasive vegetation.

- Abate any potential vectors by filling holes in the ground in and around the swale and by insuring that there are no areas where water stands longer than 48 hours following a storm. If mosquito larvae are present and persistent, contact the Contra Costa Mosquito and Vector Control District for information and advice. Mosquito larvicides should be applied only when absolutely necessary and then only by a licensed individual or contractor.

► PLANTER BOXES

Planter boxes capture runoff from downspouts or sheet flow from plazas and paved areas. The runoff briefly floods the surface of the box and then percolates through an active soil layer to drain rock below. Typical maintenance consists of the following:

- Examine downspouts from rooftops or sheet flow from paving to ensure that flow to the planter is unimpeded. Remove any debris and repair any damaged pipes. Check splash blocks or rocks and repair, replace, or replenish as necessary.
- Examine the overflow pipe to make sure that it can safely convey excess flows to a storm drain. Repair or replace any damaged or disconnected piping.
- Check the underdrain piping to make sure it is intact and unobstructed.
- Observe the structure of the box and fix any holes, cracks, rotting, or failure.
- Check that the soil is at the appropriate depth to allow a reservoir above the soil surface and is sufficient to effectively filter stormwater. Remove any accumulations of sediment, litter, and debris. Till or replace soil as necessary. Confirm that soil is not clogging and that the planter will drain within 3-4 hours after a storm event.
- Determine whether the vegetation is dense and healthy. Replace dead plants. Prune or remove any overgrown plants or shrubs that may interfere with planter operation. Clean up fallen leaves or debris and replenish mulch. Remove any nuisance or invasive vegetation.

► INFILTRATION TRENCHES AND DRY WELLS

Infiltration trenches and dry wells store runoff and allow it to infiltrate into native soil. The primary objective of maintenance is to avoid entry of fine sediments which may clog the soil interface. Typical inspection and maintenance tasks include the following:

- Inspect periodically and following major storms. Remove any accumulated trash or sediment.
- Clean out sediment traps and pre-filters.

- Check observation wells 2-3 days after storms to confirm drainage.
- Repair any erosion at inflow or overflow structures.
- Mow and trim vegetation around the trench or dry well.

Upon failure (when the device fails to drain within 72 hours) the trench or dry well must be renovated. Typically this requires removal of rock fill and accumulated sediment, scarification of the bottom, replacement of filter fabric, and refilling the trench or dry well with clean rock fill.

► WET, EXTENDED WET DETENTION, DRY DETENTION, & INFILTRATION BASINS

These larger-scale BMPs remove pollutants by detaining runoff in a quiescent pool long enough for some of the particulates to settle to the bottom. They require both routine (preventative) maintenance and non-routine maintenance.

For any basin, vault or other device that is designed to hold, or does hold water for longer than 72 hours, the following will typically be required:

- A copy of the O&M plan must be provided to the Contra Costa Mosquito and Vector Control District (CCMVCD).
- Access to all potential vector-producing areas will be given to CCMVCD personnel.
- Copies of O&M reports will be supplied to CCMVCD.
- The CCMVCD will be given advance notice of O&M activities such as silt management, vegetation management, and water management.
- A schedule of routine O&M activities will be given to the CCMVCD.
- O&M personnel will cooperate with CCMVCD and adjust activities as necessary to facilitate control of mosquitoes and vectors.

Typical routine maintenance consists of the following:

- Examine inlets to ensure that piping is intact and not plugged. Remove accumulated sediment or debris near the inlet.
- Examine outlets and overflow structures and remove any debris or sediment that could plug the outlets. Identify and correct any sources of sediment and debris. Check rocks or other armoring and replace as necessary.

- Inspect embankments, dikes, berms, and side slopes for signs of erosion or structural deficiencies.
- Confirm that any fences around the facility are secure.
- Control vectors by filling any holes in or around the pond and examine the pond for evidence of mosquito larvae.

Typical non-routine maintenance includes the following:

- Dredge accumulated sediment. This may be required every five to 15 years, and more frequently if there are excess sources of sediment (as may occur on newly constructed sites where soils are not yet stabilized). Dredging is usually a major project requiring mechanized equipment. The work will include an initial survey of depths and elevations; sediment sampling and testing; removal, transport, and disposal of accumulated sediment, and reestablishment of original design grades and sections.
- Remove invasive plants. Depending on the success of the design and the rate of sedimentation, ponds may be subject to excessive growth of rooted macrophytes, which reduce the effective area of the pond and create quiescent surface water that supports mosquito larvae. Removal may require a level of effort similar to dredging.

Step 3: Stormwater Control O&M Plan

After the construction drawings and specifications for your stormwater treatment and hydrograph modification BMPs have been completed, prepare a Stormwater Control Operation and Maintenance (O&M) plan.

The O&M plan may be simple or complex depending on the type of BMPs selected and implemented for your project. For example, scheduled maintenance for landscape detention areas may require little more explanation than irrigation cycles, plant care, and observation of any drainage problems. In contrast, a system with pumps and sumps should incorporate manufacturer's maintenance recommendations, warranty information, detailed operating plans, and a seasonal schedule for inspections. Wet ponds or constructed wetlands will require detailed O&M plans to monitor and, if necessary, abate problems with mosquitoes or excessive macrophyte growth. In addition, it may be advisable to manage wet ponds or wetlands to avoid designation as critical habitat for endangered species.

Appendix F provides instructions for the preparation of O&M plans. Example Stormwater Control Operation and Maintenance Plans are in Appendix J.

Step 4: Interim Operation & Maintenance

In accordance with Provision C.3.e.ii. of the Stormwater NPDES permit, the project proponent must provide a signed statement "accepting responsibility for maintenance [of stormwater treatment BMPs] until the responsibility is transferred to another entity…"

Include a statement to this effect in your Stormwater Control Plan.

The detailed O&M plan should incorporate solutions to any problems noted or changes that occurred during construction. For this reason, the detailed O&M plan may be submitted at the end of the construction period, before the application for final building permit and Certificate of Occupancy.

Step 5: Transfer Responsibility

As part of the detailed O&M plan, note the expected date when responsibility for operation and maintenance will be transferred. Notify your municipality when this transfer of responsibility takes place.

Step 6: Operation & Maintenance Verification

Each Contra Costa municipality will implement a Stormwater Treatment Measures Operation and Maintenance Verification Program, including periodic site inspections. The local verification program is described in Appendix K.

References and Resources

- *Start at the Source* (BASMAA, 1999) pp. 139-145.
- *Urban Runoff Quality Management* (WEF/ASCE, 1998). pp 186-189.
- *Stormwater Management Manual* (Portland, 2002). Chapter 6.0.
- *California Storm Water Best Management Practice Handbooks* (CASQA, 2003).
- *Best Management Practices Guide* (Public Telecommunications Center for Hampton Roads, 2002).
- Contra Costa Clean Water Program *Vector Control Plan*
- *Operation, Maintenance, and Management of Stormwater Management Systems* (Watershed Management Institute, 1997)

Chapter 7

Alternative Compliance Options

Alternatives for meeting stormwater control requirements for your site by participating in a regional stormwater facility, by implementing compensatory mitigation, or obtaining an exemption.

Contra Costa municipalities may establish an alternative compliance program or, in the absence of such a program, allow a particular project to implement "alternative compliance" in lieu of incorporating stormwater treatment BMPs into their project.

Under certain conditions, a project applicant may choose to reduce or omit treatment BMPs from their project design. Instead, applicants may create an equivalent water-quality benefit at a different site. Where feasible, this site should be in the same drainage basin.

Local Requirements

Cities, towns, or the County may have requirements that differ from, or are in addition to, this countywide Guidebook. See Appendix A and check with local planning and community development staff.

Other C.3 requirements—including site designs to minimize imperviousness and structural and operational source control BMPs—will still apply.

The Program recommends that you follow the steps in Chapter 3 to prepare a Stormwater Control Plan for your project before considering options for alternative (off-site) compliance.

Should an alternative compliance option be necessary, the Stormwater Control Plan for your project site is still needed to detail how site design measures, source control BMPs and other remaining on-site requirements will be met and will also help establish that on-site treatment measures are infeasible or impracticable, if that is the case.

"Alternative compliance" may be implemented by pursuing any of the following three options:

1. Participate in a **regional stormwater treatment facility**.
2. Demonstrate the **impracticability** of incorporating treatment BMPs on your development site **and** also demonstrate how you will provide **compensatory mitigation** (equivalent treatment or equivalent water-quality benefit) at another site.
3. Obtain an **exemption** from the requirements if impracticability of incorporating treatment BMPs on your site can be established, the costs of participating in a regional facility or implementing compensatory mitigation at another site would "unduly burden" the project, and the project is a redevelopment project that also meets certain categorical criteria established by the Water Board.

Provision C.3.g of the stormwater NPDES permit details the Water Board's requirements for "alternative compliance."

Local planning and engineering staff can provide up-to-date information on your municipality's proposed "alternative compliance" program or requirements and how they might apply to your project.

References and Resources

- San Francisco Bay RWQCB Order No. R2-2003-0022 (Stormwater NPDES Permit C.3 Amendment), Provision C.3.g

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Appendix

A

Local Exceptions & Requirements

Municipality-specific procedures, policies, and submittal requirements.
Obtain from your municipal planning department.

The Contra Costa Clean Water Program C.3 web page includes links to each Contra Costa municipality's C.3 information.

Appendix

B

Model Conditions of Approval

Your municipality may incorporate your Stormwater Control Plan into Conditions of Approval attached to permits to complete your project.

Conditions of approval may include:

- Prior to issuance of permits for building, site improvements, or landscaping, the permit application shall be consistent with the applicant's approved Stormwater Control Plan and shall include drawings and specifications necessary to implement all measures in the approved Plan. The permit application shall include a completed "Construction Plan C.3 Checklist" as described in the *Stormwater C.3 Guidebook*.

- As may be required by [specify divisions or authorities within the agency], drawings submitted with the permit application (including structural, mechanical, architectural, grading, drainage, site, landscape, and other drawings) shall show the details and methods of construction for site design features, measures to limit directly connected impervious area, pervious pavements, self-retaining areas, treatment BMPs, permanent source control BMPs, and other features that control stormwater flow and potential stormwater pollutants.

- The applicant shall submit the building permit application for [Agency's] review and approval and shall be responsible to implement and pay all costs associated with preparation of the building permit application.

- Prior to building permit final and issuance of a Certificate of Occupancy, the applicant shall execute any agreements identified in the Stormwater Control Plan which pertain to the transfer of ownership and/or long-term maintenance of stormwater treatment or hydrograph modification BMPs.

- Prior to building permit final and issuance of a Certificate of Occupancy, the applicant shall submit, for the review and approval of [Agency], a Stormwater BMP Operation and Maintenance Plan in accordance with [Agency] guidelines. Guidelines for the preparation of Stormwater BMP Operation and Maintenance Plans are in Appendix F of the *Stormwater C.3 Guidebook*.

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Appendix

C

Stormwater Infiltration Guidelines

How to select feasible and effective stormwater infiltration systems for your development site.

Infiltration can be the most cost-effective method to manage stormwater—if conditions on your site allow.

Site planning and site grading can minimize runoff and promote infiltration on most sites. Planters, swales, and bioretention areas can be used on sites with native clay soils—if the devices are built with imported soils and underdrains. Where native soils are more permeable, infiltration basins, infiltration trenches, or dry wells may be used, if the devices are designed to protect groundwater quality.

Read this appendix for an overview of when, where, and how stormwater infiltration is feasible. "Rules of thumb" and matrices will help you determine which of the various methods work best on your site.

Appendix C Contents

The Program has created a tool to facilitate queries of the County's geographic information system (GIS). By providing an Assessor's Parcel Number (APN) or coordinates, you can obtain a text summary of the available information on slopes, soil types, geologic hazards, and other factors that may affect the feasibility of infiltration on your site. Use this report as a starting point for further investigation of site conditions by a qualified professional.

The Program has also assembled fact sheets, including sample designs, for the most widely used infiltration systems. See Attachment C-1.

What is Stormwater Infiltration?

As a stormwater management method, infiltration means retaining or detaining water within soils to reduce runoff.

There are three possible routes from rainfall to stream flow (Figure C-1):

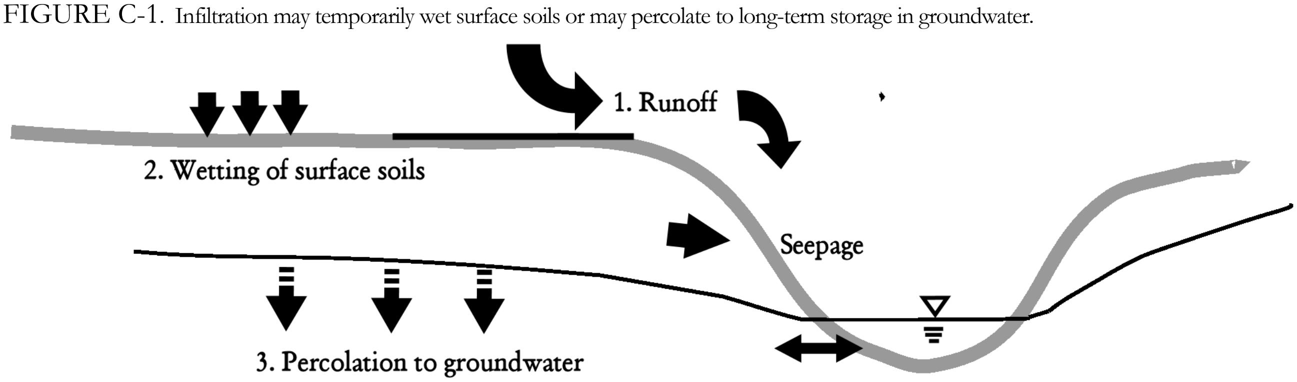
1. Rainfall on impervious surfaces becomes runoff and is almost immediately conveyed to streams via pipes or open channels. A relatively small amount wets surfaces or is caught in small depressions. This is called initial abstraction.

2. Some rainfall on pervious areas enters soil pores and increases the soil moisture content. The soil continues to absorb some or all rainfall—depending on rainfall intensity and soil characteristics—until it becomes saturated. On slopes, water may seep from surface soils and become runoff or streamflow.

3. Some moisture percolates downward to the water table where it enters groundwater (deep infiltration). Groundwater may be stored for months or years and may migrate through aquifers to emerge as surface flow some distance away.

In undeveloped areas, the proportion of total rainfall that follows each of these routes depends on rainfall frequency, rainfall intensity, soil characteristics, vegetation, and slopes.

FIGURE C-1. Infiltration may temporarily wet surface soils or may percolate to long-term storage in groundwater.



Typically, land development covers formerly pervious areas with roofs and pavement. In addition, vegetation may be removed and soils may be compacted. All of these changes tend to increase surface runoff and decrease infiltration to soils and groundwater. The increased intensity and duration of runoff transports more pollutants and also may erode and destabilize stream beds and banks.

These effects can be partially mitigated by enhancing stormwater infiltration.

Stormwater Infiltration Methods

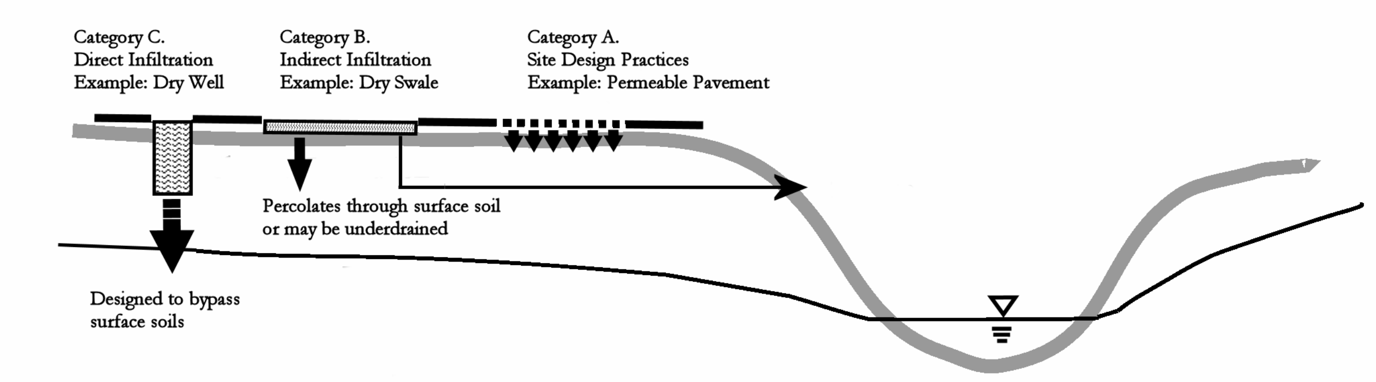
Stormwater infiltration methods may be categorized as follows (Figure C-2):

A. Site design practices which, while having a significant effect on runoff and infiltration, are very much integrated into the overall process of land development. These practices include laying out the site to reduce impervious area, routing drainage from building roofs, and selecting of surface treatments when designing site grading and paving. Site design practices must be integrated with the site's urban design, architecture, landscape architecture, and engineering as part of a multifaceted design solution.

B. Indirect infiltration methods, including swales and bioretention areas. These features are expressly designed to hold runoff and allow it to percolate into surface soils. Runoff may reach groundwater indirectly, or may be underdrained into subsurface pipes.

C. Direct infiltration methods, which are designed to bypass unsaturated surface soils and transmit runoff directly to groundwater. Devices must be located and designed to limit the potential for stormwater pollutants to reach groundwater. Direct infiltration methods include dry wells and infiltration trenches.

FIGURE C-2. Stormwater Infiltration Methods: (A) Site Design Practices, (B) Indirect Infiltration, and (C) Direct Infiltration



Specific infiltration methods are summarized in Table C-1 and discussed below. "Fact sheets" for some methods, including example designs, are in Attachment C-1.

TABLE C-1. Description of specific infiltration methods and facilities.

Method / Facility	*Description*
A. Site Design Practices	
Site Layout Practices	Examples: Concentrate development on least sensitive portions of the site; preserve pervious soils and natural drainage features; minimize the amount of impervious area by using shared parking, efficient site circulation and by designing taller buildings with smaller footprints or tuck-under parking,
Green Roofs	May be "extensive" with a 3-7 inch lightweight substrate and a few types of low-profile, low-maintenance plants, or may be "intensive" with a thicker substrate, more varied plantings, and a more garden-like appearance.
Disconnected Downspouts	Rather than connecting directly to storm drains, extended leaders direct roof runoff away from the building to nearby landscape detention, pop-up emitters, or infiltration devices.
Cisterns	Above ground storage vessels, sometimes with a manually operated valve, store runoff for post-storm discharge to landscaping.
Amending Soils	Soil amendments and tilling enhance or restore permeability and storage in the top layer of soils, reducing runoff.
Structural Soils	An engineered mix of angular aggregate and clayey loam provides structural support for sidewalks and paving while creating void spaces to support urban tree roots.
Site Grading	Using gentler slopes and concave areas to reduce runoff and encourage infiltration.
Pervious Pavements	Special mixes of concrete and asphalt. Require a base course of crushed aggregate and installation by experienced crews.
Unit Pavers	Traditional bricks, stone, or other pavers on sand or fine crushed aggregate.
B. Indirect Infiltration	
Flow-through Planter Box	Contained planter, usually above-ground, holds runoff in a surface reservoir and lets it infiltrate through a layer of soil. Infiltrated runoff collects in a gravel layer below, seeps into a perforated pipe underdrain, and is drained to a storm drain or discharge point.
Infiltration Planter	In-ground planter collects runoff from roofs and paved surfaces and allows it to percolate through permeable soil. May require an underdrain if the underlying native soils are poorly drained.
Bioretention	Briefly ponds stormwater on the surface of a shallow depression and allows it to percolate through permeable soil. May require underdrains if underlying native soils are poorly drained.
Vegetated or Grassy Swale	Works like bioretention, but also transmits high flows along its length.
C. Direct Infiltration	
Infiltration Basin	An excavation exposes relatively permeable soils and impounds water for rapid infiltration.
Dry Well	Small, deep hole filled with open graded aggregate. Sides may be lined with filter fabric or may be structural (i.e., an open bottom box sunk below grade). Typically receives roof runoff.
Infiltration Trench	Trench, with no outlet, filled with rock or open graded aggregate.

Factors Affecting Feasibility of Infiltration

A variety of factors may limit or prevent use of a particular stormwater infiltration method on a particular site. Some factors, such as clayey soils or high groundwater, make direct infiltration infeasible. However, it may be possible to use indirect infiltration methods on these sites if water percolating through surface soils is underdrained and prevented from reaching groundwater.

Table C-2 summarizes the factors that may limit the feasibility of a particular stormwater infiltration method on a particular site.

The factors include:

Terrain. Stormwater infiltration is most feasible on flatter sites. Surface flows applied to slopes may run off rather than soaking into the ground. On hillsides, infiltrated runoff will tend to surface a short distance downstream and may also cause geotechnical instability (see below).

Soil types. The United States Department of Agriculture Natural Resources Conservation Service (NRCS, formerly the Soil Conservation Service) classifies soil types into four hydrologic soil groups.

- Group A soils are typically sands, loamy sands or sandy loams. Group A soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.

- Group B soils are typically silt loams or loams. They have a moderate infiltration rate when thoroughly wetted and consist chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.

- Group C soils are typically sandy clay loams. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.

- Group D soils are typically clay loams, silty clay loams, sandy clays, silty clays or clays. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.

Surface soils in much of Contra Costa County are in Group C or Group D. A few areas in the eastern part of the County have Group A soils. There are a few pockets of Group A and B soils scattered throughout the County. Infiltration through Group C and Group D soils is generally infeasible. However, surface infiltration may be possible if surface soils are amended or imported and are sufficiently well-drained (by underdrains if necessary).

Geotechnical considerations. Increased water pressure in soil pores reduces soil strength, making foundations more susceptible to settlement and slopes more susceptible to failure. In general, infiltration areas or devices must be set back from building foundations or steep slopes. Specific requirements for each site should be determined by a qualified geotechnical engineer.

Depth to groundwater. To protect groundwater quality, the Water Boards require devices designed for direct infiltration have a 10-foot minimum separation between the bottom of the device and the high seasonal groundwater level.

Potential groundwater pollution. The Water Boards prohibit direct infiltration of runoff from some land uses, including industrial or light industrial areas; areas subject to high vehicular traffic (25,000 or greater average daily traffic on main roadway or 15,000 or more average daily traffic on any intersecting roadway); automotive repair shops; car washes; fleet storage areas (bus, truck, etc.), nurseries, and other areas where there is a high potential for pollutants in runoff. See Table C-3.

Existing groundwater pollution. Infiltration should be avoided where it could contribute to the movement or dispersion of previously polluted groundwater. This includes sites listed by the Water Boards' Leaking Underground Storage Tanks (LUST) and Spills, Leaks, Investigations, and Complaints (SLIC) programs.

Vector control and maintenance. Infiltration systems must be designed and maintained to ensure long-term performance and to avoid harboring mosquitoes and other vectors. Detailed design and maintenance requirements for specific systems are on the accompanying information sheets. Infiltration systems should not be used on sites where the design criteria cannot be achieved or where maintenance over the life of the project cannot be assured.

TABLE C-2. Typical factors that may restrict feasibility of stormwater infiltration on a particular site.
Blank cells mean: This factor is typically not a barrier to implementing this infiltration method.

<table>
<tr><th>Infiltration Method</th><th>Terrain
(Surface Slope)</th><th>Geotechnical Considerations</th><th>Soils</th><th>Potential Groundwater Pollution</th></tr>
<tr><td>Site Design Practices</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Site Layout Practices</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Green Roofs</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Disconnected Downspouts</td><td>Not suitable on slopes >4% unless terraced</td><td>Extend leaders away from and downslope of structures</td><td></td><td></td></tr>
<tr><td>Cisterns</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Amending Soils</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Structural Soils</td><td rowspan="2">Not suitable on slopes >4% unless terraced</td><td rowspan="2">Set back from structures</td><td></td><td></td></tr>
<tr><td>Site Grading</td><td></td><td></td></tr>
<tr><td>Pervious Pavements</td><td></td><td></td><td rowspan="2">Use a thicker base of drainage rock and positive drainage over poorly draining soils</td><td></td></tr>
<tr><td>Unit Pavers</td><td></td><td></td><td></td></tr>
<tr><td>Indirect Infiltration</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Flow-through Planter Box</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Infiltration Planter</td><td>Not suitable for slopes; planter must be level</td><td rowspan="3">Protect adjacent pavement and structures from infiltrating moisture. Generally not suitable on slopes that exceed 15%.</td><td rowspan="3">Provide underdrains in poorly draining (Groups “C” and “D”) soils</td><td></td></tr>
<tr><td>Bioretention</td><td>Not suitable for slopes; use underdrained planter boxes instead</td><td></td></tr>
<tr><td>Vegetated or Grassy Swales</td><td>Not suitable for slopes >6%</td><td></td></tr>
<tr><td>Direct Infiltration</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Infiltration Basin</td><td colspan="2" rowspan="3">Generally not suitable where slopes exceed 15%. Set back from structures.</td><td rowspan="3">May not be feasible in “C” soils. Not suitable in “D” soils.</td><td rowspan="3">Not allowed in industrial areas and high-traffic streets. Minimum depth to groundwater required. Set back from wells. See Table C-3.</td></tr>
<tr><td>Dry Well</td></tr>
<tr><td>Infiltration Trench</td></tr>
</table>

TABLE C-3. Guidelines on the Use of Direct Infiltration Devices

Direct Infiltration device: "Any structure that is designed to infiltrate storm water into the subsurface, and as designed, bypasses the natural groundwater protection afforded by surface or near-surface soil."

Examples

Dry well: Structure placed in an excavation or boring, or excavation filled with open-graded rock, that is designed to collect stormwater and infiltrate into the subsurface soil.

Infiltration basin: Shallow impoundment that is designed to infiltrate stormwater into subsurface soil.

Infiltration and exfiltration trench: Long narrow trench filled with permeable material (e.g. gravel), which may contain perforated pipe (exfiltration), designed to store runoff and infiltrate through the bottom and sides into the subsurface soil. Includes French drain.

Criteria for Direct Infiltration	
Groundwater separation (default)	> 10 feet from bottom of device to seasonal high groundwater.
Land use activities in drainage area	No high-risk land uses, including industrial, automotive repair shops, car washes, fleet storage areas, nurseries, landfills, and agricultural uses. No hazardous materials, chemical storage, or waste disposal.
Level of vehicular traffic	<25,000 ADT main roads; <15,000 ADT minor roads
Horizontal setbacks:	
Drinking water wells (active or not properly decommissioned)	> 100 feet
Septic Systems	> 100 feet
Underground storage tanks with hazardous materials	> 500 feet
Hillside stability	Recommend geotechnical analysis when slopes are > 7%

Reference: Water Board Order R2-2003-0022, Provision C.3.i

Design and Maintenance for Vector Control

The general design principles to be applied are:

- Design structures so that they do not hold standing water for more than 72 hours.[1] Special attention to groundwater depth is essential.
- Locate and design facilities to avoid entry of fine sediment, which may cause systems to clog and fail and may also result in standing water.

[1] CCMVCD personnel note that the following minimum mosquito production periods are typical to Contra Costa County: December-February, two weeks; April-May, 10 days; June-October, 3-5 days (3-4 days in areas that are exceptionally warm in summer). Devices that hold standing water fewer than five days will rarely cause problems.

- Select locations that will allow flow by gravity to, through, and away from the facility. Pumps are not recommended because they are subject to failure and often require sumps.

- Design distribution piping and containment basins with adequate slopes to drain fully and prevent standing water. Take into consideration the buildup of sediment between maintenance periods. Compaction during grading may be needed to avoid slumping and settling, which can create depressions that will hold water. However, avoid compaction of infiltration areas.

- Avoid the use of loose riprap or concrete depressions that may hold standing water.

- Avoid barriers, diversions, or flow spreaders that may retain standing water.

- Completely seal structures that retain water permanently or longer than 72 hours to prevent entry of adult mosquitoes. Adult female mosquitoes can penetrate openings as small as $^1/_{16}$ inch to gain access to water for egg laying. Screening can exclude mosquitoes but is subject to damage and is not a method of choice.

- Design devices with the appropriate pumping, piping, valves, or other necessary equipment to allow for easy dewatering if necessary.

- Design devices for easy access for inspection and without the need for confined-space entry.

Maintenance requirements include the following:

- Observe soil at the bottom of the swale or filter for uniform percolation throughout. If portions of the swale or filter do not drain within 48 hours after the end of a storm, the soil should be tilled, replanted, or replaced. Remove any debris or accumulations of sediment.

- Confirm that check dams and flow spreaders are in place and level and that channelization within the swale or filter is effectively prevented.

Procedure for Selecting Infiltration Systems

The following procedure is recommended:

1. Review the “Rules of Thumb” below.

2. Obtain a Screening Report for Your Site

3. Complete Your Site Investigation

4. Document Your Design

► RULES OF THUMB

In practice, the best stormwater infiltration method for a particular site is most likely to be determined by the following considerations (or rules of thumb):

- Site design practices—including green roofs, disconnected downspouts, cisterns, amended soils, structural soils, grading landscaping to a concave form, and pervious pavements—are applicable to most sites and can be used to reduce the required number or size of direct and indirect infiltration systems.

- Infiltration to groundwater is generally not feasible on steep or unstable slopes. Site layout practices (limiting impervious area) may be appropriate if approved by a geotechnical engineer. Runoff may be detained or treated in green roofs and cisterns or in flow-through planter boxes or similar systems which have been isolated from underlying soils by an impermeable liner.

- On sites with clay soils (Hydrologic Soil Group "C" or "D"), swales or bioretention areas may be used if drainage is sufficient or underdrains are provided. Some indirect infiltration to groundwater will occur and will enhance the effectiveness of these systems. Site design practices such as disconnected downspouts and pervious paving may be used if soils are amended and positively drained.

- On sites with well-drained soils (Hydrologic Soil Group "A" or "B"), direct infiltration by dry wells or infiltration trenches may be the most low-cost and space-efficient method for managing stormwater, subject to restrictions on land uses, depth to groundwater, and proximity to wells. (See Table C-3.) The potential for clogging with fine sediments should also be considered. If any of these limitations are present, swales or bioretention areas may be used to treat stormwater before it percolates to the permeable native soils underneath.

► SCREENING REPORT

The Contra Costa Clean Water Program has developed a simple way to obtain relevant available data for any particular location within the County. In response to input of an Assessor's Parcel Number (APN) for a site or coordinates for a particular location, the Program's query tool will produce a brief text report summarizing:

- Hydrologic soil groups.

- Land-use categories.

- Heavily trafficked roadways.
- Slopes.
- Recorded geologic hazards.
- Known locations of potential soil and/or groundwater contamination.
- Presence of vulnerable groundwater areas or existing water supply wells.

The query tool presents information available for locations on or near the site. It is also possible to map applicable information at and near the site.

The resulting report and graphics should be used as a template and a starting point for investigation, by competent professionals, of existing conditions and stormwater management options specific to the site.

An example report is shown in Attachment C-2.

► COMPLETE YOUR SITE INVESTIGATION

Based on the "rules of thumb" and the report produced by the Program's query tool, consider the stormwater infiltration options that may be suitable to your site.

If you plan to use site design practices and indirect infiltration methods (swales and bioretention areas), proceed to preliminary sizing and design of these facilities.

If you plan to use direct infiltration, you will need to investigate further to confirm infiltration rates of soils at proposed locations of the infiltration devices. Infiltration testing methods are in Attachment C-3.

In addition, further investigation should be conducted of:

- Depth to groundwater, based on well logs, boring logs, or other available data.
- Vulnerable groundwater areas and water supply wells, based on a review of past uses of the site, visual evidence, and records.
- Potential soil or groundwater contamination, based on a review of past uses of the site, visual evidence, and records.

► DOCUMENT YOUR DESIGN

Chapter Five of the Program's *Stormwater C.3 Guidebook* includes instructions for sizing and preliminary design of stormwater management facilities. The Chapter Five procedure emphasizes the use of roof runoff controls to reduce runoff and the use of grading, paving, and landscaping techniques to create self-retaining areas. Runoff from impervious areas can be routed to Integrated Management

Practices (IMPs), which include direct and indirect infiltration devices. The *Stormwater C.3 Guidebook* also includes minimum requirements and checklists for a Stormwater Control Plan to be submitted with applications for planning and zoning review.

The information sheets in Attachment C–1 will assist development of preliminary and final design for stormwater infiltration facilities.[1]

Category A: Site Design Practices

C–1–1	Green Roofs	1 pp.
C–1–2	Downspouts and Cisterns	2 pp.
C–1–3	Grading, Paving, and Landscaping	2 pp.

Category B: Indirect Infiltration Practices

C–1–4	Flow-through Planter	2 pp.
C–1–5	Infiltration Planter	2 pp.
C–1–6	Bioretention	3 pp.
C–1–7	Vegetated or Grassy (“Dry”) Swale	3 pp.

Category C: Direct Infiltration Practices

C–1–8	Infiltration Basin	3 pp.
C–1–9	Dry Well	3 pp.
C–1–10	Infiltration Trench	3 pp.

As described in *Guidebook* Chapters 5 and 6, locate and design your stormwater management facilities to ensure access for maintenance and to minimize the potential for harboring vectors.

References and Resources

- RWQCB Order R2-2003-0022, Provision C.3.i—Limitation on Use of Infiltration Treatment Measures—Infiltration and Groundwater Protection
- USEPA Fact Sheet, “When are Storm Water Discharges Regulated as Class V Wells?”
- *Start at the Source* (BASMAA, 1999).
- *California Storm Water Best Management Practice Handbooks* (CASQA, 2003) Fact Sheets
  Bioretention
  Extended Detention Basin
  Infiltration Basin
  Infiltration Trench
  Retention/Irrigation
  Vegetated Swale
- www.greenroofs.org
- “Structural Soil: An Innovative Medium Under Pavement that Improves Street Tree Vigor,” Cornell University Urban Horticulture Institute.

[1] Fact sheets are provided for some, but not all, of the “Category A—Site Design Practices” discussed in the text and listed in Table C-1. See Chapter 3 of this *Stormwater C.3 Guidebook* and the References and Resources above for additional guidance on site design.

Attachment C-1

Infiltration Systems Fact Sheets

Green Roofs

Gap Headquarters, San Bruno (*William McDonough & Partners*)

Green roofs can be either *extensive*, with a 3"-7" lightweight substrate and a few types of low-profile, low-maintenance plants, or *intensive* with a thicker (8" to 48") substrate, more varied plantings, and a more garden-like appearance.

The extensive installation pictured above, at Gap Headquarters in San Bruno, has experienced relatively few problems after nearly a decade in use.

Design and Construction. Extensive green roof systems contain several layers of protective materials to convey water away from the roof deck. Starting from the bottom up, a waterproof membrane is installed, followed by a root barrier, a layer of insulation (optional), a drainage layer, a filter fabric for fine soils, the engineered growing medium or soil substrate, and the plant material.

Design and installation is typically by an established vendor.

Maintenance. Installations require inspection at least semiannually and may or may not require irrigation in the Bay Area semi-arid climate.

Agilent Headquarters, Santa Clara (*Agilent*)

See www.greenroofs.com for information about and more examples of green roofs.

Best Uses

- New buildings with innovative architecture
- Urban centers

Advantages

- Minimize roof runoff
- Reduce "heat island" effect
- Absorb sound
- Provide bird habitat
- Structural requirements similar to other roofing options (for extensive green roofs).
- Maintenance costs similar to other roofing options

Limitations

- Sloped roofs require steps or cross-battens
- Non-traditional design

CONTRA COSTA CLEAN WATER PROGRAM

Infiltration Feasibility Fact Sheets

Category A—Site Design Practices

Downspouts and Cisterns

Construction Innovation Forum *Better Homes & Gardens*

Drainage from roofs can be directed to pervious areas and allowed to infiltrate into the soil. No further treatment or detention is required if the ratio of impervious to pervious area does not exceed 2:1. "Self-retaining" pervious areas must be graded and designed to retain at least 1" rainfall over the entire area, as described in the fact sheet for grading, paving, and landscaping practices.

Splash blocks, swales, or pipes direct downspout discharge away from foundations to lawns or planting beds. Shallow depressions, or "rain gardens," may collect and detain runoff.

Cisterns or rain barrels can capture and detain a portion of the runoff and allow it to seep away slowly. These devices may have a valve to control when and how fast they empty. Cisterns can also expand the effective capacity of dry wells, infiltration trenches, and other infiltration practices.

Design and Construction. Cisterns or rain barrels can be fashioned from a variety of materials. Cisterns capable of retaining water for more than 72 hours must be sealed against entry by mosquitoes, which can enter openings as small as $^{1}/_{16}$".

Maintenance. Maintenance consists of inspecting cisterns and piping and removing any accumulated sediment.

Best Uses

- Landscaped areas near buildings

Advantages

- Low-cost
- Versatile
- Conserves water
- Low maintenance

Limitations

- Soils receiving runoff must be adequately drained.
- Foundations should be protected from excessive moisture in expansive clay soils.
- Impervious-to-pervious ratio should not exceed 2:1.
- Bay Area seasonal rainfall patterns make water storage somewhat less attractive.

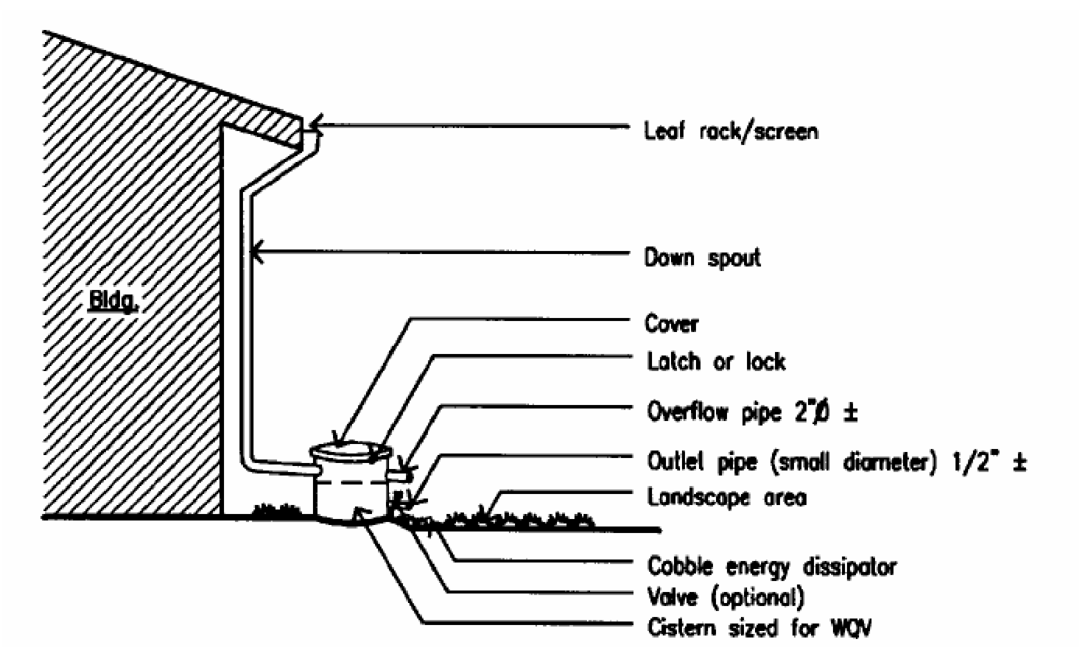
Contra Costa Clean Water Program

Infiltration Feasibility Fact Sheets

Category A—Site Design Practices

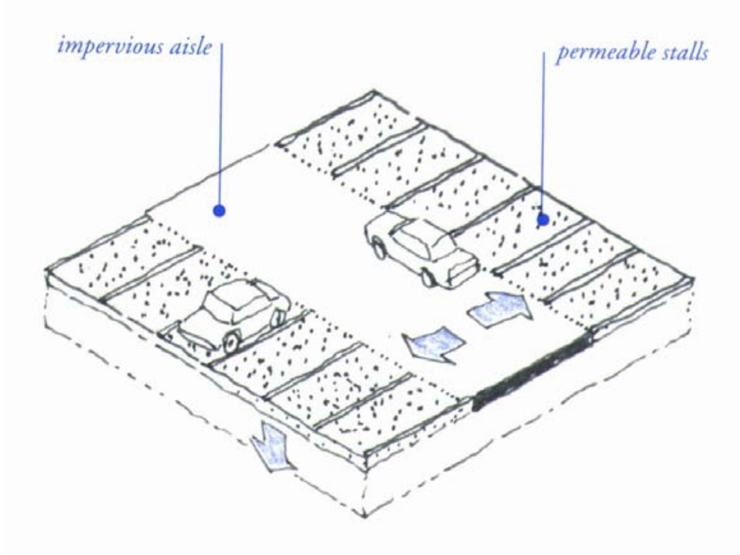
Design Checklist for Downspouts and Cisterns

- ❒ Discharge is directed away from foundations.
- ❒ Receiving landscaped area is at least ½ tributary impervious (roof) area.
- ❒ Receiving landscaped area is designed to retain runoff (see Grading, Paving, and Landscaping Fact Sheet).
- ❒ Slopes do not exceed 4% (unless terraced).
- ❒ Cistern valve or orifice designed to allow slow drainage.
- ❒ Cistern designed to drain completely within 72 hours or are tightly sealed against mosquito entry.
- ❒ Cistern overflow is directed to avoid damage.
- ❒ Cistern is designed to protect against access by small children (secure or less than 4" diameter top opening).



Bay Area Stormwater Management Agencies Association, *Start at the Source* (1999)

Grading, Paving, and Landscaping



Bay Area Stormwater Management Agencies Association, *Start at the Source* (1999)

The need for stormwater treatment can be minimized by designing pervious areas so that they retain the first 1" of rainfall before any runoff enters storm drains. In paved areas, permeable pavements may substitute for traditional asphalt or concrete.

Runoff from roofs or impervious paving can be allowed to drain on to pervious areas without any additional requirement for stormwater treatment. Up to a 2:1 ratio of impervious area to pervious area is acceptable.

Where native soils are clayey, a thick gravel base course provides additional storage under permeable pavements. In some cases, an underdrain system, connected to the storm drain or leading to a discharge point, may be needed.

Design and Construction. Grade landscaped areas to be concave. If drains are necessary, set the inlet elevation above the low point or drainage line. Select pervious pavements to serve site aesthetics and uses. Pervious concrete is most suitable to low-traffic areas. Turf block pavers may be appropriate for overflow parking areas. Unit pavers such as brick, and crushed aggregate, are used in plazas and pedestrian walkways.

Maintenance. Permeable asphalt and concrete may require periodic pressure washing or vacuuming to dislodge fines. Unit pavers may require seasonal weed suppression.

Best Uses

- Parking lots
- Common areas
- Lawns and landscape buffers

Advantages

- Reduce or eliminate need for stormwater treatment
- Does not require annual verification of maintenance
- Reduce drainage system cost and potential for flooding
- Can be an attractive landscape element

Limitations

- Potential for prolonged ponding if soils are poorly drained
- New varieties of pervious asphalt and concrete have not yet been widely accepted
- Typically higher costs for pervious pavements

Contra Costa Clean Water Program

Infiltration Feasibility Fact Sheets

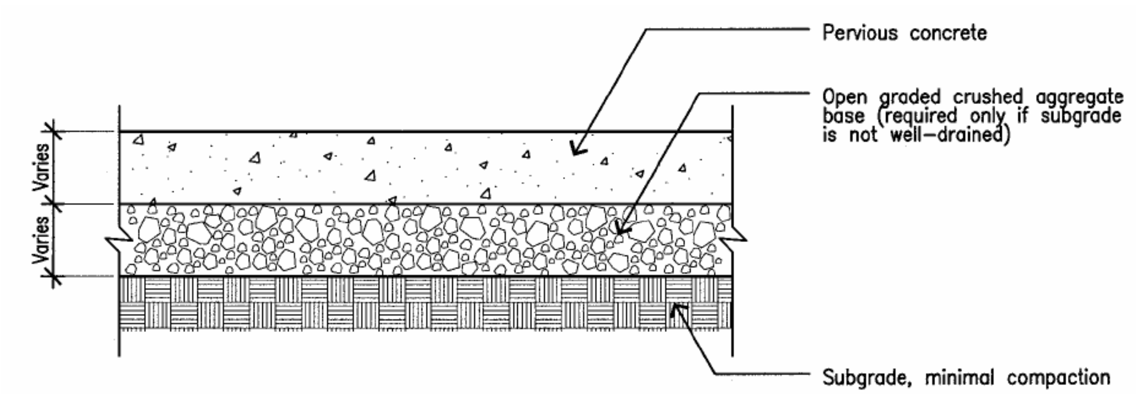
Category A—Site Design Practices

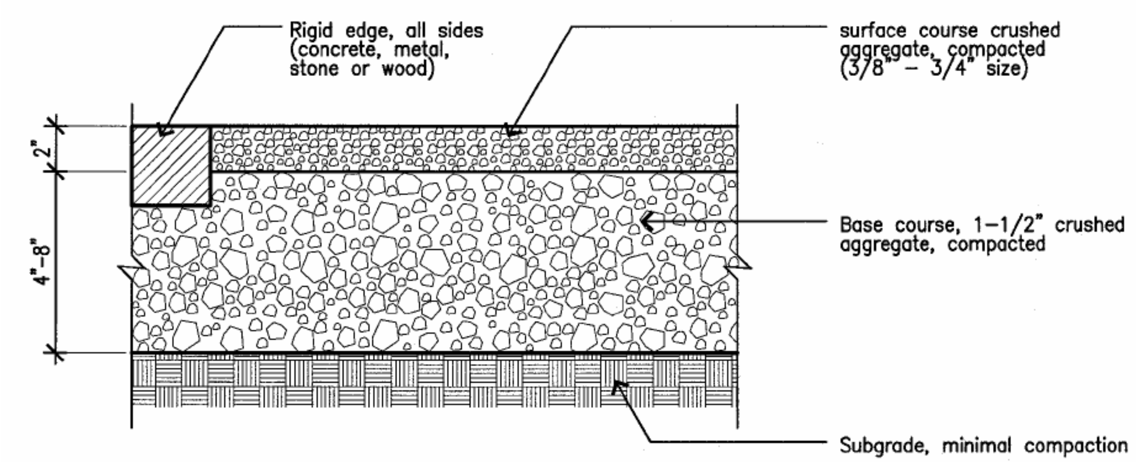
Design Checklist for Landscaped Self-Retaining Areas

- ❐ Entire self-retaining area is graded concave (i.e., will retain 1" rainfall over entire surface). Drain inlets, if any, are set above low point or flow line.
- ❐ Receiving landscaped area is at least ½ tributary impervious area.
- ❐ Lawn or other landscaped areas are graded with at least 6" curb reveal below adjacent pavement (to allow for turf growth without blocking sheet flow into landscaped area).
- ❐ Soils are suitable or will be adequately amended with organic matter to increase moisture-holding capacity.
- ❐ In clay soils: Slopes, gravel underlayer, and/or underdrain will protect against prolonged ponding.

Design Checklist for Permeable Pavements

- ❐ No erodable areas drain on to pavement.
- ❐ Reservoir base course is of open-graded crushed stone. Base is adequate to retain rainfall and to support loads.
- ❐ Subgrade is uniform and slopes are not so steep that subgrade is prone to erosion.
- ❐ Rigid edge is provided to retain granular pavements and unit pavers.
- ❐ Permeable pavements will be installed by experienced professionals according to vendor's recommendations.
- ❐ Selection and location of pavements incorporates Americans with Disabilities Act requirements, site aesthetics, and uses.





Bay Area Stormwater Management Agencies Association, *Start at the Source* (1999)

Flow-through Planter

City of Portland *2004 Stormwater Manual*

Flow-through planters are designed to treat and detain runoff without allowing seepage into the underlying soil. They can be used next to buildings and other locations where soil moisture is a potential concern.

Flow-through planters typically receive runoff via downspouts leading from the roofs of adjacent buildings. However, flow-through planters can also be set level with the ground and receive sheet flow. (See the Infiltration Planter fact sheet.)

Pollutants are removed as the runoff passes through the soil layer and is collected in an underlying layer of gravel or drain rock. A perforated pipe underdrain must be piped to a storm drain or other discharge point. An overflow inlet conveys flows which exceed the capacity of the planter.

Design and Construction. Infiltration planters in Contra Costa County may be designed with a 0.04 sizing factor (surface area of planter/surface area of tributary impervious area). A sandy loam with a minimum infiltration rate of 5"/hour is required.

Plantings should be selected for viability in a well-drained soil. Irrigation is required to maintain plant viability.

Maintenance. Maintain vegetation and irrigation system; inspect periodically and after storms to ensure structural integrity and that planter has not clogged.

Best Uses

- Retention and treatment of roof runoff
- Next to buildings
- Dense urban areas
- Where infiltration is not desired

Advantages

- Can be used next to structures
- Space-efficient
- Versatile
- Can be any shape
- Low maintenance

Limitations

- Requires underdrain
- Requires sufficient head between inlet and underdrain
- Requires careful selection of plant palette
- Must be installed level
- Typically requires irrigation

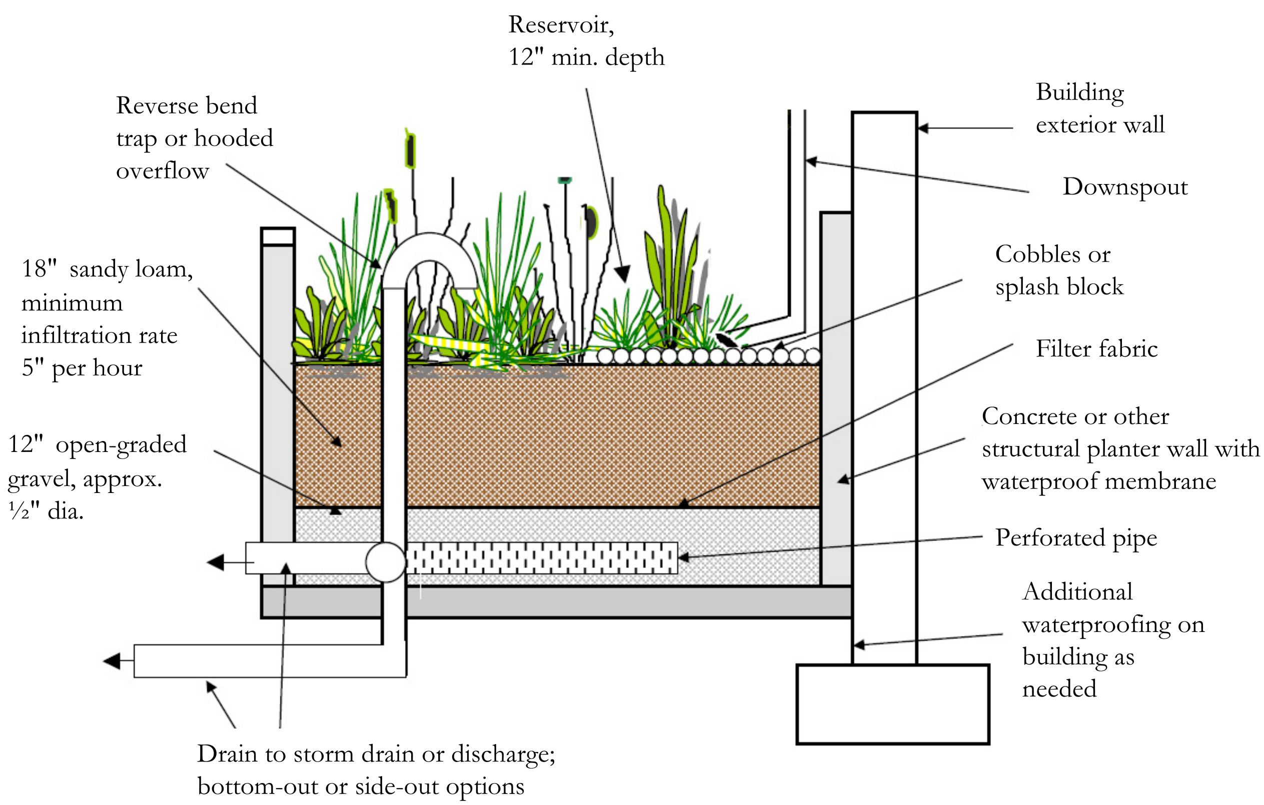
CONTRA COSTA CLEAN WATER PROGRAM

Infiltration Feasibility Fact Sheets

Category B—Indirect Infiltration Practices

Design Checklist for Flow-through Planter

- ❐ Ratio (surface area of planter)/(tributary impervious area) does not exceed 0.04.
- ❐ Planter is installed level.
- ❐ Overflow adequate to meet municipal drainage requirements
- ❐ Minimum 12" deep reservoir at top of planter
- ❐ 18" deep sandy loam with minimum infiltration rate of 5"/hour.
- ❐ 12" deep pea gravel or crushed rock.
- ❐ Filter fabric between soil and gravel layers
- ❐ Perforated pipe underdrain with cleanouts and connection to storm drain or discharge point.
- ❐ Adequate head from underdrain to storm drain or discharge point.
- ❐ Waterproofing as required to protect groundwater or building foundations.
- ❐ Splash blocks or cobbles at downspouts and inlet pipes
- ❐ Plants selected for viability and to minimize need for fertilizers and pesticides.
- ❐ Irrigation system with connection to water supply.



Adapted from the City of Portland *2004 Stormwater Manual*

Infiltration Planter

City of Portland *2004 Stormwater Manual*

Infiltration planters may receive runoff by piped inlet (see illustration on reverse) or by sheet flow across the adjoining pavement. An overflow inlet conveys flows which exceed the infiltration capacity of the planter. Pollutants are removed as runoff passes through the soil layer and is collected in an underlying layer of gravel or drain rock.

Treated runoff may be allowed to infiltrate into the underlying native soil. A perforated pipe underdrain must be incorporated into the design when native soils are clayey (hydrologic soil groups "C" and "D") or when infiltration is not desired. The underdrain must be piped to a storm drain or other discharge point.

Design and Construction. Infiltration planters in Contra Costa County may be designed with a 0.04 sizing factor (surface area of planter/surface area of tributary impervious area). A sandy loam with a minimum infiltration rate of 5"/hour is required. Infiltration planters can be designed with curbs and curb-cut inlets (min. 12" width), which may be poured monolithically with the planter walls. Plantings should be selected for viability in a well-drained soil. Irrigation is required to maintain plant viability.

Maintenance. Maintain vegetation and irrigation system; inspect periodically to ensure structural integrity and that the planter has not clogged.

Best Uses

- Parking lot islands
- Plazas
- Along walkways

Advantages

- Space-efficient
- Versatile
- Can be any shape
- Low maintenance

Limitations

- Requires underdrain in clay soils
- Requires careful selection of plant palette
- Irrigation required to maintain plant viability.
- Must be installed level

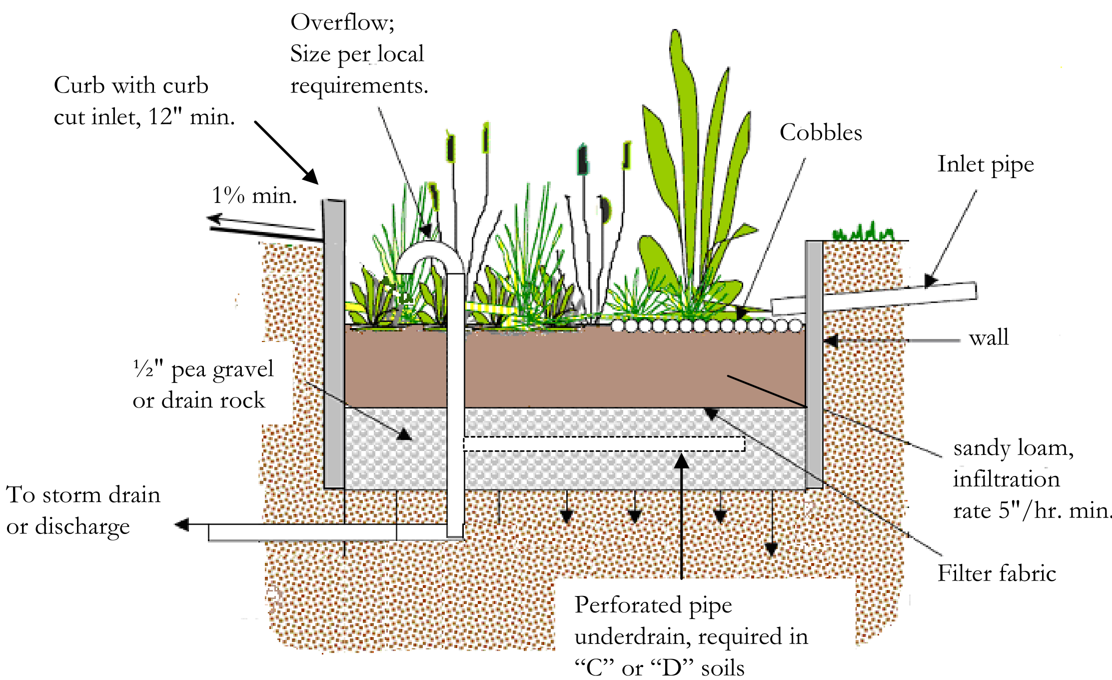
Contra Costa Clean Water Program

Infiltration Feasibility Fact Sheets

Category B—Indirect Infiltration Practices

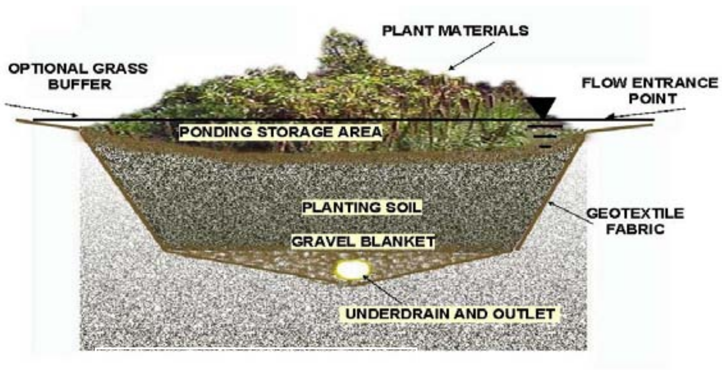
Design Checklist for Infiltration Planter

- ❐ Set back from structures 10' minimum or as required by structural or geotechnical engineer.
- ❐ Ratio (surface area of planter)/(tributary impervious area) does not exceed 0.04.
- ❐ Planter is installed level.
- ❐ Overflow adequate to meet municipal drainage requirements
- ❐ Minimum 12" deep reservoir at top of planter
- ❐ 18" deep sandy loam with minimum infiltration rate of 5"/hour.
- ❐ 12" deep pea gravel or crushed rock.
- ❐ Filter fabric between soil and gravel layers
- ❐ Perforated pipe underdrain (in "C" and "D" soils and where infiltration rate of native soils is less than 0.5"/hour) with cleanouts and connection to storm drain or discharge point.
- ❐ If underdrain required, adequate head exists to reach storm drain or discharge point.
- ❐ 12" minimum width of curb cut
- ❐ Splash blocks or cobbles at inlets and inlet pipes
- ❐ Plants selected for viability and to minimize need for fertilizers and pesticides.
- ❐ Native soils protected against compaction during construction.
- ❐ Irrigation system with connection to water supply.



Adapted from the City of Portland *2004 Stormwater Manual*

Bioretention Areas



(Prince George's County 1993)

Bioretention areas remove stormwater pollutants through a combination of overland flow through vegetation, surface detention, and filtration through soil.

Treated runoff may be allowed to infiltrate into the underlying native soil. A perforated pipe underdrain must be provided for installations where native soils are clayey (hydrologic soil groups "C" and "D") or infiltration is not desired.

Design and Construction. Bioretention areas in Contra Costa County may be designed with a 0.04 sizing factor (surface area of bioretention/tributary impervious area). The topsoil must be a minimum of 18" deep and have a minimum infiltration rate of 5"/hour. A typical soil mix comprises 50% construction sand, 20-30% topsoil with less than 5% maximum clay content and 20-30% organic leaf compost.

Beneath the soil, a layer of drain rock or pea gravel, up to 4' deep, stores treated runoff before it seeps into the native soil or underdrain.

Surface ponding depths should be between 4" and 12". Plant species should be suitable to the well-drained soil and occasional inundation. If desired, larger trees are best planted at the periphery of the area.

Maintenance. Soils and plantings must be maintained, including routine pruning, replenishment of mulch, and weeding. The bioretention area should be inspected regularly and after storms. Erosion at inflow points must be repaired.

Best Uses

- Commercial, mixed-use and multi-family sites
- To treat runoff from areas up to 2 acres
- As a landscape design element

Advantages

- Low maintenance
- Reliable operation once established
- Versatile planting options

Limitations

- Vegetation requires frequent maintenance until established
- Irrigation typically required to maintain plant viability

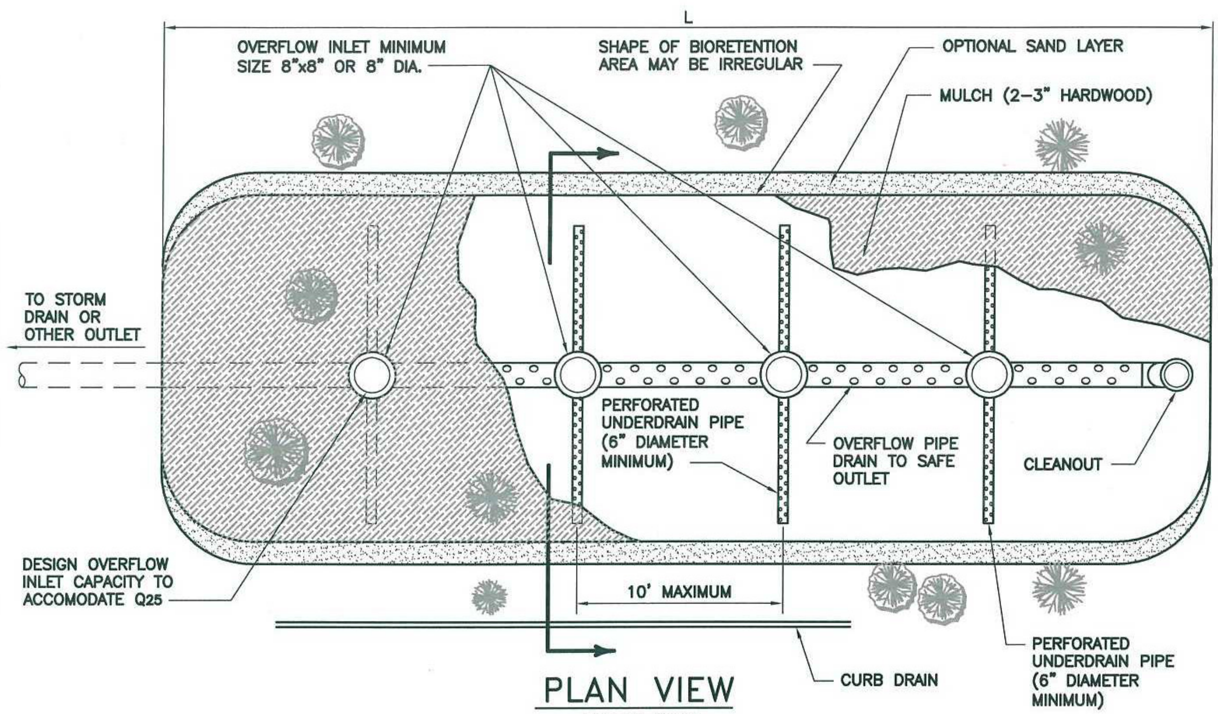
CONTRA COSTA CLEAN WATER PROGRAM

Infiltration Feasibility Fact Sheets

Category B—Indirect Infiltration Practices

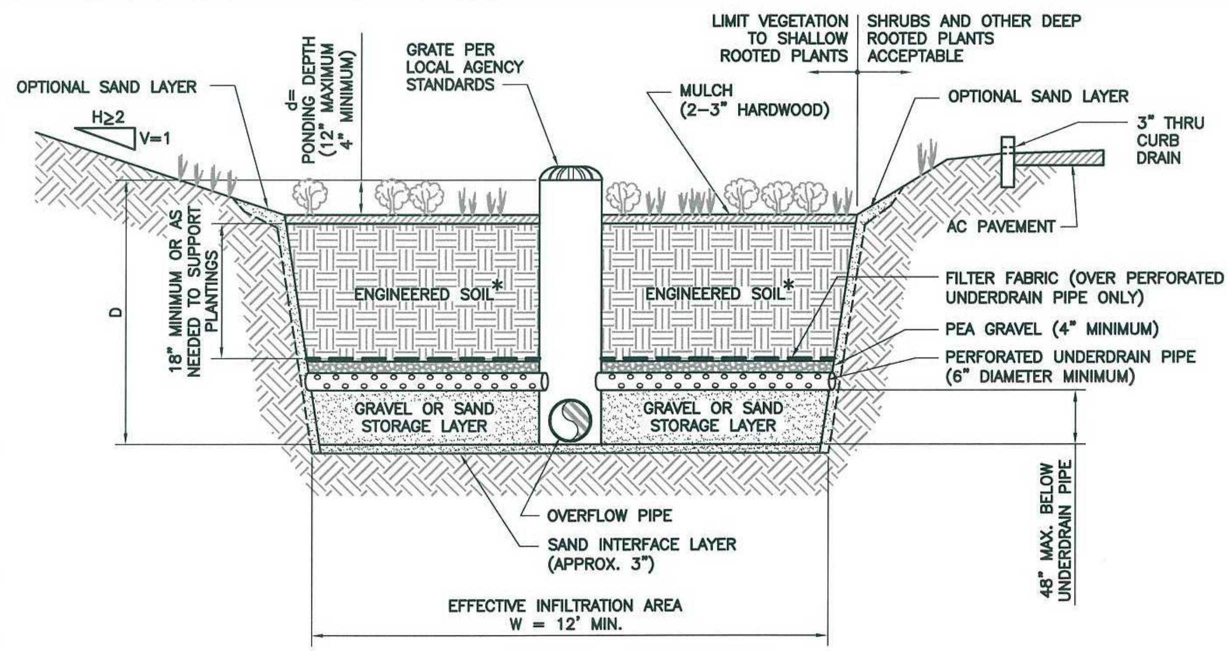
Design Checklist for Bioretention

- ❒ Set back from structures 10' or as required by structural or geotechnical engineer.
- ❒ Ratio (surface area of planter)/(tributary impervious area) does not exceed 0.04.
- ❒ Tributary impervious area does not exceed 2 acres.
- ❒ Tributary area does not contain a significant source of soil erosion.
- ❒ 50' minimum setback from, and no connection to, any on-site septic system or leach field.
- ❒ Sloped areas immediately adjacent to the bioretention area are less than 20%—but greater than 0.5% for pavement and greater than 1% for vegetated areas.
- ❒ Side slopes do not exceed 2:1
- ❒ Design ponding depth is between 4" and 12"
- ❒ Surface is covered with 2"–3" mulch
- ❒ Inlets are protected with rock or splash blocks. Curb cuts have 12" minimum width.
- ❒ Overflow inlet can safely convey design flood flows to a downstream storm drain or discharge point.
- ❒ Plantings are suitable to the climate and a well-drained soil with seasonal, periodic inundation.
- ❒ Irrigation system with connection to water supply.
- ❒ Trees and vegetation do not block inflow, create traffic or safety issues, or obstruct utilities.
- ❒ The planting mixture consists of a mixture of sand (40%), compost (20-30%) and topsoil (30-40%) with a minimum infiltration rate of 5"/hour and adequate nutrient content to meet plant growth requirements.
- ❒ Filter fabric between soil and gravel layers.
- ❒ Perforated pipe underdrain (in "C" and "D" soils and where infiltration rate of native soils is less than 0.5"/hour) with connection to storm drain or discharge point.
- ❒ Underdrain has a clean-out port consisting of a vertical, rigid, non-perforated PVC pipe, with a minimum diameter of 6 inches and a watertight cap fit flush with the ground.
- ❒ When excavating, avoid smearing of the soils on bottom and side slopes. Minimize compaction of native soils. Protect the area from construction site runoff.



PLAN VIEW

NOT TO SCALE



CROSS–SECTION

NOT TO SCALE

NOTES:

1. ALL PERFORATED PIPE SHALL HAVE A MINIMUM OF THREE 3/4" DIAMETER HOLES, EQUALLY SPACED ALONG THE CIRCUMFERENCE OF THE PIPE AND NOT LESS THAN THREE HOLES PER LINED FOOT OF PIPE.

2. DETERMINE DIMENSIONS FROM L x W x D = INFILTRATION DESIGN VOLUME.

* SANDY LOAM/LOAMY SAND; FINES SHOULD BE LIMITED TO TWENTY PERCENT OR LESS PASSING THROUGH A #200 SIEVE.

SOURCE: MODIFIED FROM PAZ, 2004

Bioretention Detail

Contra Costa Clean Water Program Infiltration Site Characterization Criteria and Guidance Study

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Vegetated or Grassy (“Dry”) Swale

City of Portland *2004 Stormwater Manual*

In a “dry” swale, pollutants are removed as runoff seeps through a layer of topsoil. Treated runoff then infiltrates into the underlying native soil. A perforated pipe underdrain is incorporated into the design where native soils are clayey (hydrologic soil groups “C” and “D”) or when infiltration is not desired. The underdrain must be piped to a storm drain or other discharge point.

Because the main mode of treatment is by filtration through the topsoil—not by settling and contact with vegetation—required detention times are minimal (~10 min.). Multiple inlets may be located along the length of the swale.

Design and Construction. Swales in Contra Costa County may be designed with a 0.04 sizing factor (surface area of swale/surface area of tributary impervious area). A sandy loam with a minimum infiltration rate of 5"/hour is required.

Swales may be planted with turfgrass or with a palette of plants and trees. If grass is used, the design should include gentle slope transitions and access for mowing equipment. Plantings should be selected for viability in a well-drained soil with occasional inundation. Irrigation is typically required to maintain plant viability.

Maintenance. Maintain vegetation and irrigation system. Inspect periodically and after storms to ensure that inlets and outlets have not clogged and rivulets have not formed.

Best Uses

- Landscape buffers
- Parking lots
- Where drainage is used as a design element

Advantages

- Provides treatment for lower flows
- Conveys high flows
- Versatile planting options
- Low maintenance

Limitations

- Minimum width required.
- May require underdrain in clay soils
- Requires careful selection of plant palette
- Typically requires irrigation

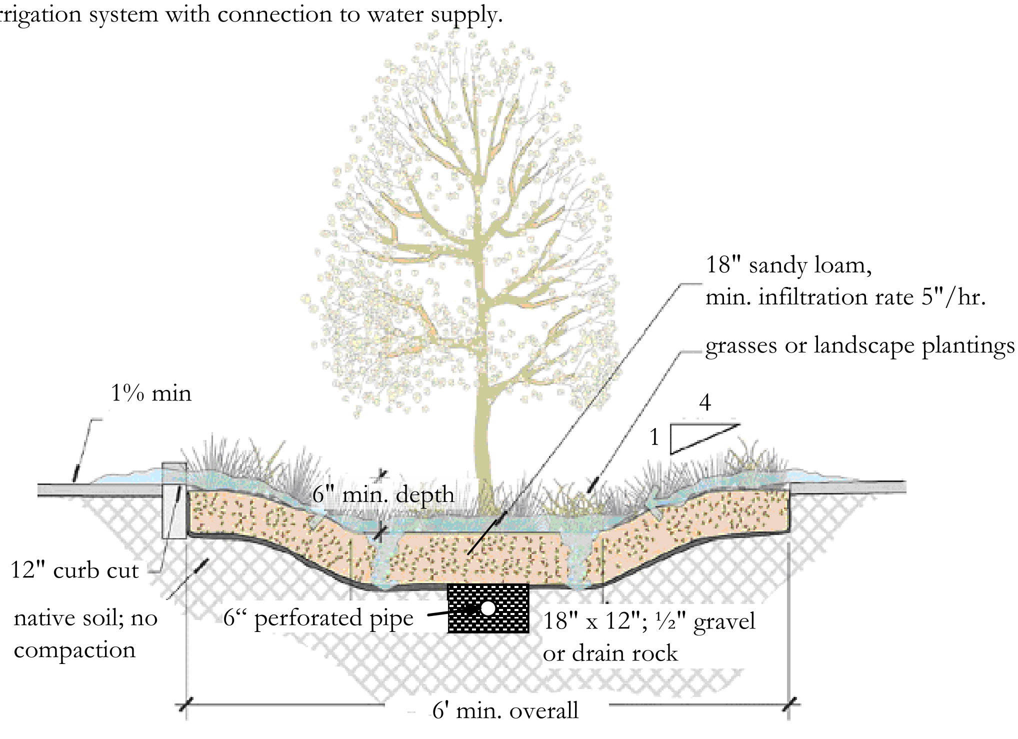
Contra Costa Clean Water Program

Infiltration Feasibility Fact Sheets

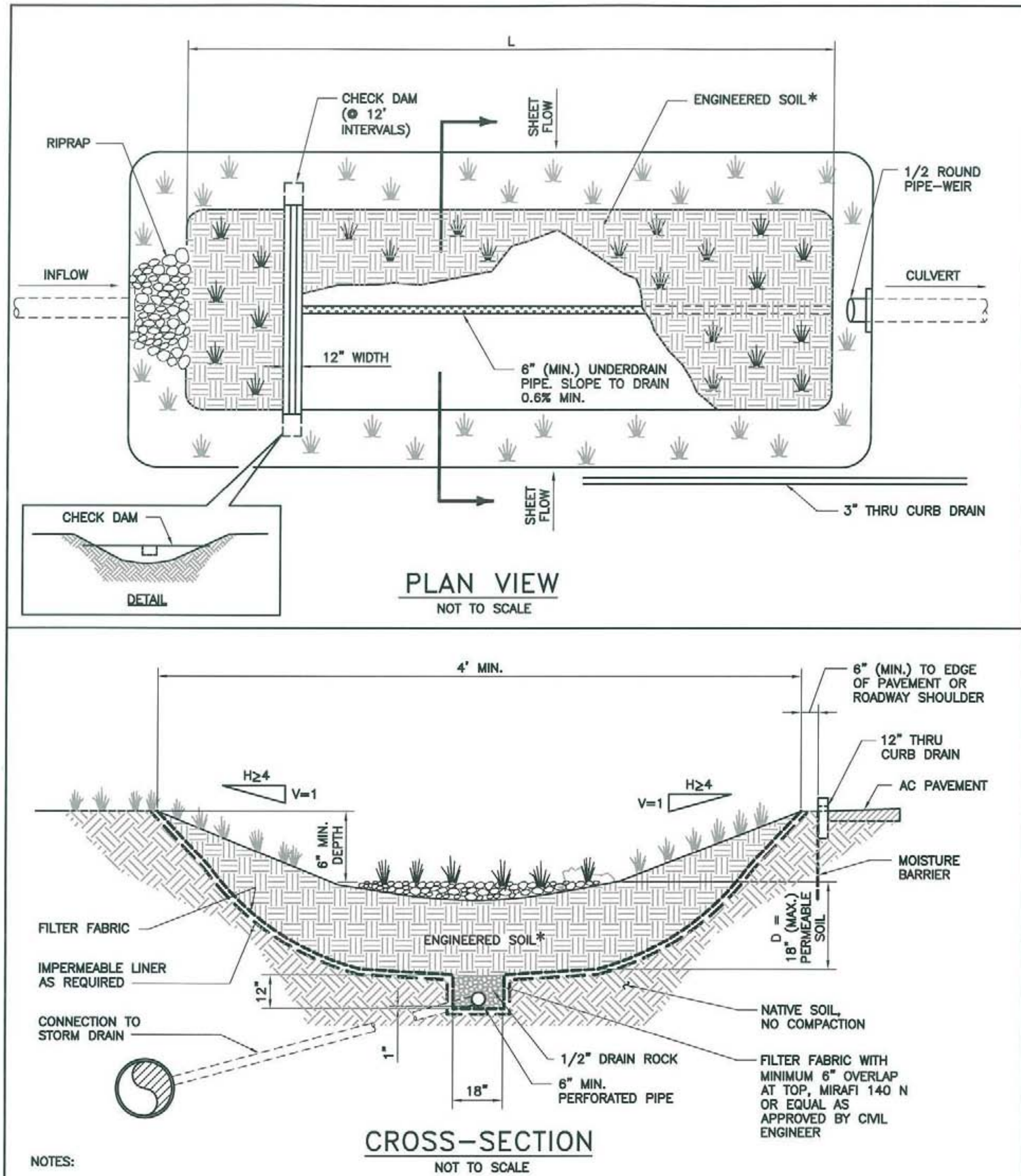
Category B—Indirect Infiltration Practices

Design Checklist for Vegetated or Grassy ("Dry") Swale

- ❐ Set back from structures 10' minimum or as required by structural or geotechnical engineer.
- ❐ Ratio (surface area of swale)/(tributary impervious area) does not exceed 0.04.
- ❐ 6" minimum depth.
- ❐ Sides slopes no greater than 4:1. Smooth transitions, particularly if vegetation must be mowed.
- ❐ Longitudinal slope between 0.2% and 6%.
- ❐ On steeper slopes, check dams fashioned of rock, concrete, or similar material extend across the swale and are keyed into the side slopes. Check dams should be a minimum of 12" wide.
- ❐ Swale can convey the flood-protection design storm (see municipal requirements).
  Suggested Manning's n = 0.025–0.040 depending on height and density of vegetation.
- ❐ 18" deep sandy loam with minimum infiltration rate of 5"/hour.
- ❐ 6" perforated pipe underdrain (in "C" and "D" soils) with connection to storm drain or discharge point.
- ❐ Perforated pipe underdrain, with cleanouts, in minimum 12" deep by 18" wide trench filled with pea gravel or crushed rock. wrapped in filter fabric.
- ❐ If an underdrain is required, adequate head exists to reach storm drain or discharge point.
- ❐ 12" minimum width of curb cut, with ½" drop across cut to avoid collection of debris.
- ❐ Splash blocks or cobbles at inlets and inlet pipes
- ❐ Plants selected for viability and to minimize need for fertilizers and pesticides.
- ❐ Native soils protected against compaction during construction.
- ❐ Irrigation system with connection to water supply.



Adapted from City of Portland *2004 Stormwater Manual*



NOTES:

1. SWALE SHALL BE GRADED TO DRAIN TOWARD OUTLET AT A MINIMUM SLOPE 0.2%
2. ALL PERFORATED PIPE SHALL HAVE A MINIMUM OF THREE 3/4" DIA. HOLES EVENLY SPACED ALONG THE CIRCUMFERENCE OF THE PIPE AND NOT LESS THAN THREE HOLES PER LINEAL FOOT OF PIPE.
3. DETERMINE DIMENSIONS FROM (L x W x D) x SOIL VOIDS RATIO = INFILTRATION DESIGN VOLUME
4. PLANTINGS MAY INCLUDE TREES, MINIMUM INFILTRATION RATE 5"/HR

* SANDY LOAM/LOAMY SAND; FINES SHOULD BE LIMITED TO TWENTY PERCENT OR LESS PASSING THROUGH A #200 SIEVE.

SOURCE: MODIFIED FROM CENTER FOR WATERSHED PROTECTION, 2000

Vegetated Swale Detail

Contra Costa Clean Water Program Infiltration Site Characterization Criteria and Guidance Study

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Infiltration Basin

Stormwater Infiltration Basin/Recreation Field—Stanford University

Infiltration basins are shallow impoundments, typically without no outlet, designed to temporarily store and infiltrate stormwater.

Suitable sites—flat, vegetated open spaces with highly permeable soils and sufficient depth to groundwater—are relatively rare in the Bay Area. The low cost of construction and low maintenance costs make infiltration basins an attractive option where they are feasible.

Design and Construction. The basin must be designed to retain the required water quality volume (see Appendix H). The soil infiltration rate must be sufficient to infiltrate the depth holding this volume within 48 hours. A safety factor of 2 is applied to the measured minimum infiltration rate.

An underdrain system is a valuable backup to ensure the basin can be drained even as soils begin to clog.

The side slopes and bottom of the basin should be vegetated with a dense turf or other water-tolerant grass immediately after construction. The root systems of healthy vegetation will help keep soil pores open and help maintain the infiltration rate.

Maintenance. The basin should be inspected following storms to ensure the infiltration rate is adequate. Inlets and stilling basins should be inspected and accumulated sediment removed. Eroded or barren areas should be re-vegetated.

Best Uses

- Flat open spaces with highly permeable soils
- Large developments

Advantages

- Can be combined with lawns, ballfields, or other park amenities
- Can serve drainage areas up to 50 acres
- Low initial cost
- Low maintenance

Limitations

- Not appropriate for clayey soils
- 10' minimum depth from bottom of basin to seasonal high groundwater
- Not suitable for industrial or “high risk” commercial areas or arterial streets
- Difficult to restore permeability once clogged.

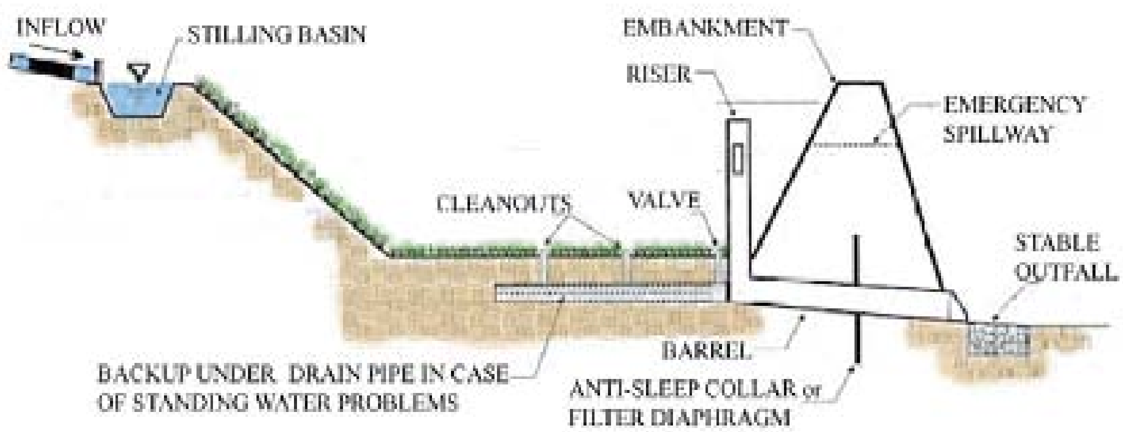
CONTRA COSTA CLEAN WATER PROGRAM

Infiltration Feasibility Fact Sheets

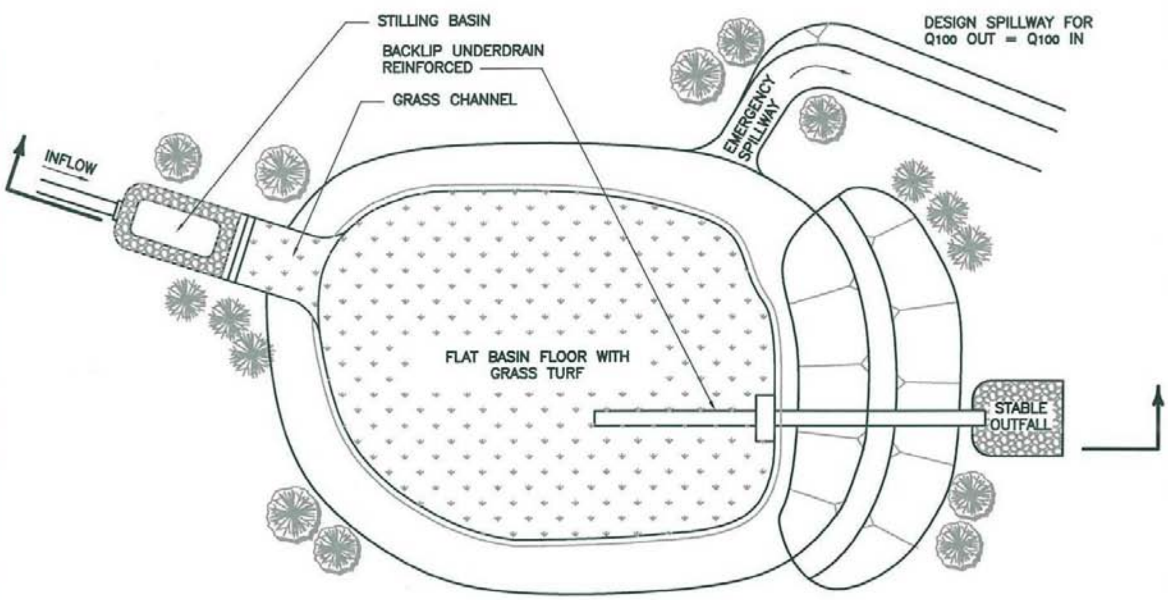
Category C—Direct Infiltration Methods

Design Checklist for Infiltration Basin

- ❐ Depth from bottom of basin to seasonally high groundwater elevation is ≥10'.
- ❐ Areas tributary to the infiltration basin do not include automotive repair shops; car washes; fleet storage areas (bus, truck, etc.); nurseries, or other uses that may present an exceptional threat to groundwater quality.
- ❐ The infiltration basin is separated by at least 100 feet from any adjacent drinking water supply wells.
- ❐ Set back basin from structures 10' or as required by structural or geotechnical engineer.
- ❐ Locations with high soil infiltration rates (≥2.4"/hr.) receive additional evaluation of potential effects on groundwater quality and need for pretreatment.
- ❐ Areas tributary to the basin do not exceed 50 acres.
- ❐ Infiltration rate at the bottom of the basin is 0.5 in/hr or greater. Soils underlying the infiltration basin do not contain more than 20 percent clay content and do not contain more than a combined 40 percent silt/clay content. Depth to bedrock is ≥ 3'.
- ❐ All upstream drainage areas are stabilized prior to construction of the infiltration trench.
- ❐ The infiltration basin is equipped with an underdrain system, with cleanouts, for dewatering and in situations when the system becomes clogged.
- ❐ The infiltration basin is designed with an emergency spillway or overflow riser to prevent uncontrolled overflows.
- ❐ The side slopes and bottom are vegetated with a dense turf of water-tolerant grass immediately following construction.
- ❐ The floor of the basin is graded uniformly as possible for uniform ponding and infiltration. Basin side slopes are no greater than 3:1. Flatter side slopes are preferred for vegetative stabilization.
- ❐ One or more simple observation wells made of perforated PVC pipe, a footplate, and locking cover is installed in the infiltration basin.



PDEP 2004



PLAN VIEW

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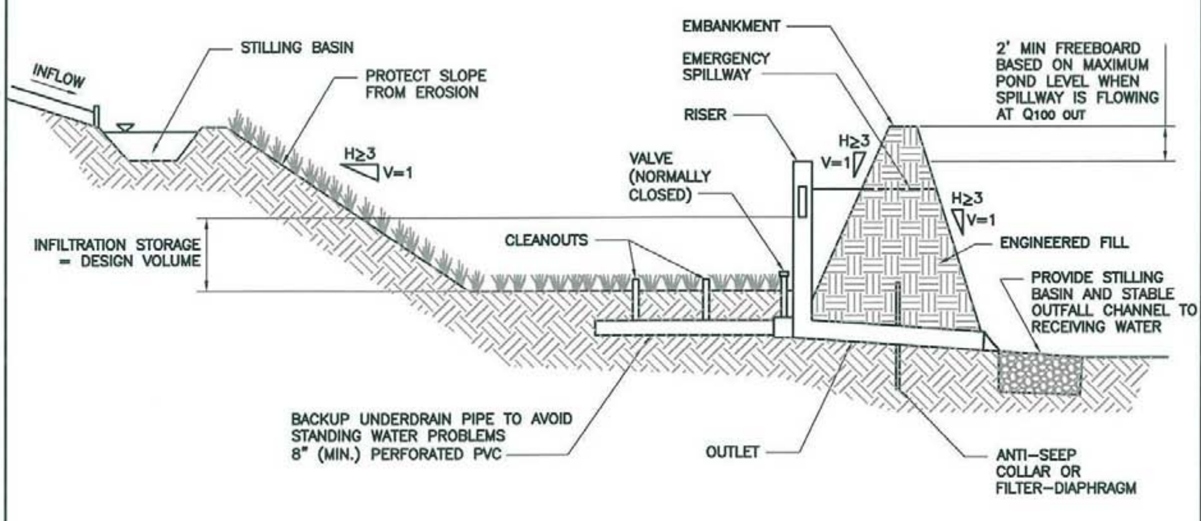

CROSS-SECTION

NOT TO SCALE

NOTES:

1. CONFIRM WHETHER OR NOT THE BASIN IS WITHIN THE JURISDICTION OF THE STATE OF CALIFORNIA DIVISION OF SAFETY OF DAMS. (HEIGHT ≥ FEET OR CAPACITY ≥ 50 ACRE-FEET.
2. THE RISER AND OUTFALL SHALL BE SIZED TO PREVENT DISCHARGE OVER THE EMERGENCY SPILLWAY WITH Q100 FLOWING INTO THE BASIN. THE DESIGN ANALYSIS SHALL ASSUME THAT THE INFILTRATION STORAGE VOLUME IS NOT AVAILABLE FOR FLOOD ROUTING ALTERNATION.

SOURCE:
MODIFIED FROM WISCONSIN DNR, 2000

Infiltration Basin Detail

Contra Costa Clean Water Program Infiltration Site Characterization Criteria and Guidance Study

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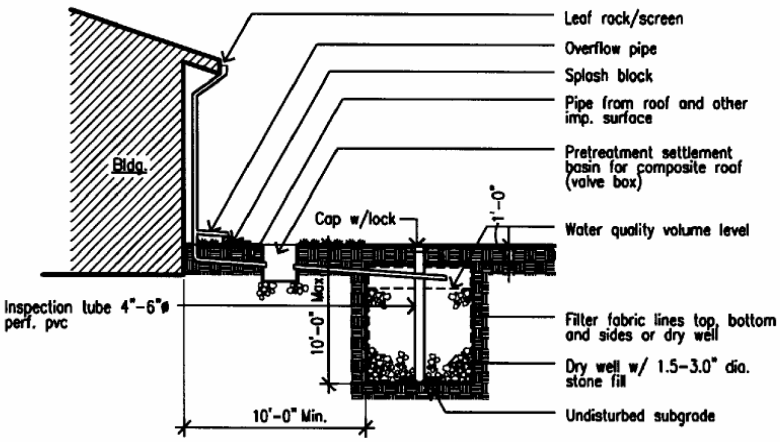
Dry Well



Bay Area Stormwater Management Agencies Association

Dry wells are typically a prefabricated structure, such as an unlined or open-bottomed vault or box, placed in an excavation or boring and filled with open-graded rock. Runoff is stored in the rock voids and allowed to infiltrate into the subsurface soil.

Design and Construction. Dry wells are typically 4' to 8' across and either cylindrical or square. Depth is typically 2' to 4', but may be deeper. A minimum of 1' but not more than 10' cover should be provided.

The dry well is sized to accommodate the required water quality volume (see Appendix H) within the void space of the rock or gravel (typically 35% of total volume). The required surface area to drain this volume within 72 hours is calculated from the infiltration rate of the underlying native soil. A simple observation well should be included and can be fashioned from a footplate, perforated PVC pipe, and a locking cover. An overflow should be provided to handle large runoff flows.

Maintenance. Dry wells should be inspected following storms to ensure water drains within 72 hours. Movement of water into the drain rock can sometimes be restored by removing and replacing the surface sand filter and filter fabric.

Best Uses

- Runoff from a single downspout

Advantages

- May be installed in parking lots and paved areas
- Compact footprint
- Can be used in areas without storm drains

Limitations

- Generally not appropriate for clayey soils (Hydrologic Soil Groups C & D)
- 10' minimum depth from bottom of trench to seasonal high groundwater
- Not suitable for industrial or “high risk” commercial areas or arterial streets
- Clogging frequency depends on amount of fine sediment in influent

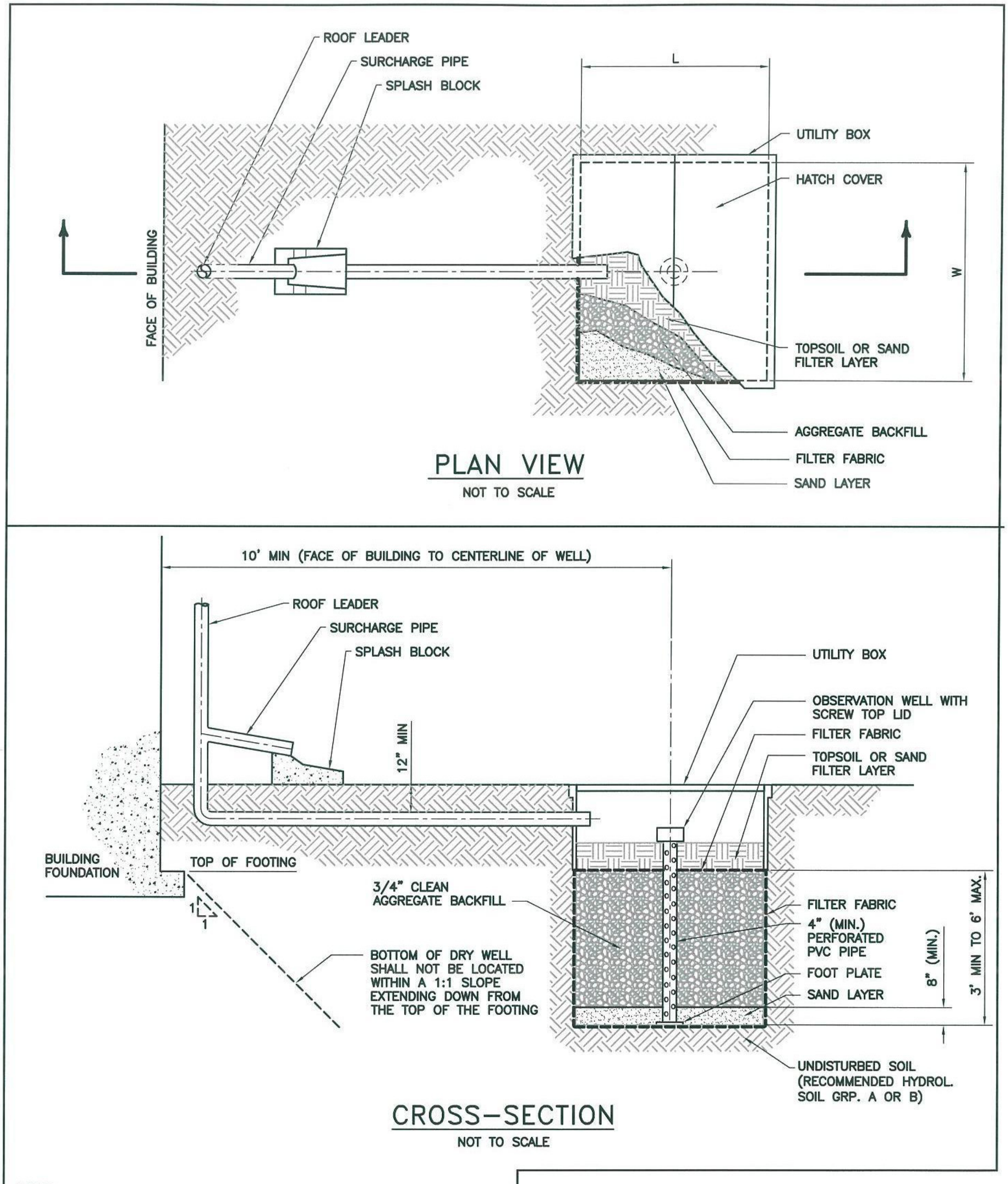
CONTRA COSTA CLEAN WATER PROGRAM

Infiltration Feasibility Fact Sheets

Category C—Direct Infiltration Practices

Design Checklist for Dry Well

- ❐ Depth from bottom of dry well to seasonally high groundwater elevation is ≥10'.
- ❐ Areas tributary to the infiltration trench do not include automotive repair shops; car washes; fleet storage areas (bus, truck, etc.); nurseries, or other uses that may present an exceptional threat to groundwater quality.
- ❐ The dry well is separated by at least 100 feet from any adjacent drinking water supply wells.
- ❐ Locations with high soil infiltration rates (≥2.4"/hr.) receive additional evaluation of potential effects on groundwater quality and need for pretreatment.
- ❐ Native soil infiltration rates are equal to or greater than 0.3 in/hr. Depth to bedrock is ≥3'.
- ❐ The drainage area is less than one acre.
- ❐ Set back from structures 10' or as required by structural or geotechnical engineer.
- ❐ An overflow is provided to handle large flows.
- ❐ An observation well is provided to allow for inspection and maintenance.
- ❐ Filter fabric is provided between the ¾" clean stone backfill and native soils
- ❐ Void spaces in trench fill accommodate the required water quality volume.
- ❐ Soil infiltration rate has been confirmed (Attachment C-3).
- ❐ Bottom surface area is sufficient to ensure drainage within 72 hours.
- ❐ Design includes an observation well.



NOTES:

1. AGGREGATE BACKFILL SHALL BE 3/4" CLEAN AGGREGATE (USE CALTRANS SPEC).
2. BOTTOM OF DRY WELL SHALL BE A MINIMUM 10' FROM SEASONAL HIGH GROUNDWATER TABLE.
3. DRY WELL SHALL BE A MINIMUM 100' HORIZONTALLY FROM ANY WATER SUPPLY WELL.

SOURCE:
MODIFIED FROM CONNECTICUT STORMWATER QUALITY MANUAL, 2004

Dry Well Detail

Contra Costa Clean Water Program Infiltration Site Characterization Criteria and Guidance Study

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Infiltration Trench

California Storm Water Quality Handbook (2003)

An infiltration trench is typically long, narrow, and filled with gravel or other permeable material. The trench stores runoff and infiltrates it through the bottom and sides into the subsurface soil. In a variation of this method, perforated drain pipes may convey and exfiltrate runoff to gravel-filled trenches and thence into the native soil.

Design and Construction. The trench is sized to accommodate the required water quality volume (see Appendix H) within the void space of the rock or gravel (typically 35% of total volume). The required surface area to drain this volume within 72 hours is calculated from the infiltration rate of the underlying native soil.

Following excavation, the trench is lined with a geotextile filter fabric. A sand layer is placed on the bottom, and the trench is backfilled with clean, open-graded gravel or rock. A horizontal layer of filter fabric is placed over the gravel or rock before a final surface layer of topsoil, sand or pea gravel. A simple observation well can be fashioned from a footplate, perforated PVC pipe, and a locking cover.

Maintenance. Trenches should be inspected following storms to ensure that water drains within 72 hours. If clogging occurs, it may be necessary to remove and replace the top layer of filter fabric and possibly the coarse aggregate fill.

Best Uses

- Mixed-use and commercial
- Parking lots
- Roof runoff

Advantages

- Simple; low-cost
- Provides disposal as well as treatment

Limitations

- Generally not appropriate for clayey soils (Hydrologic Soil Groups C & D)
- 10' minimum depth from bottom of trench to seasonal high groundwater
- Not suitable for industrial or "high risk" commercial areas or arterial streets
- Clogging frequency depends on amount of fine sediment in influent

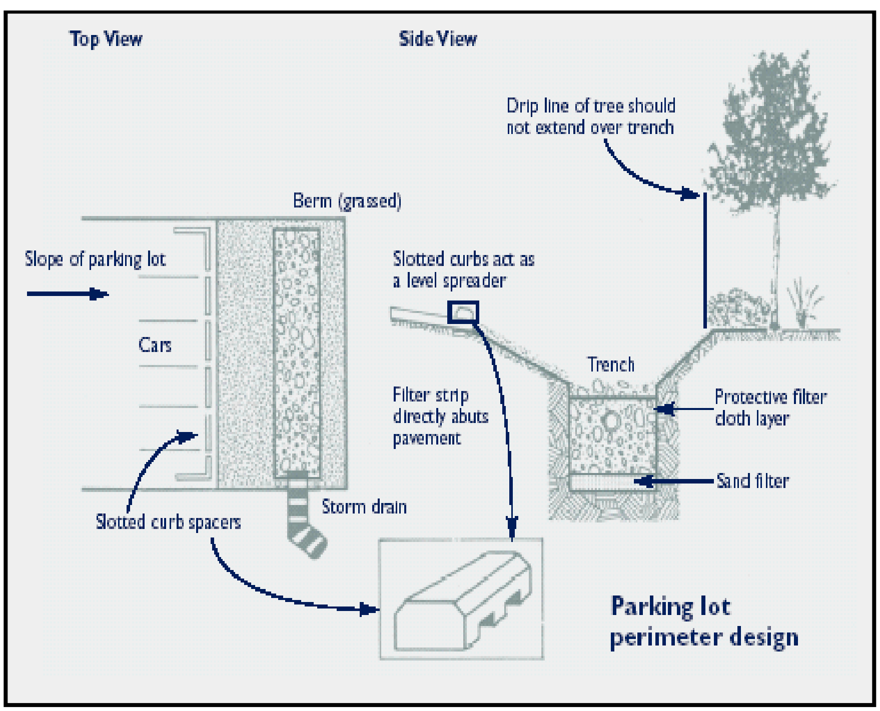
Contra Costa Clean Water Program

Infiltration Feasibility Fact Sheets

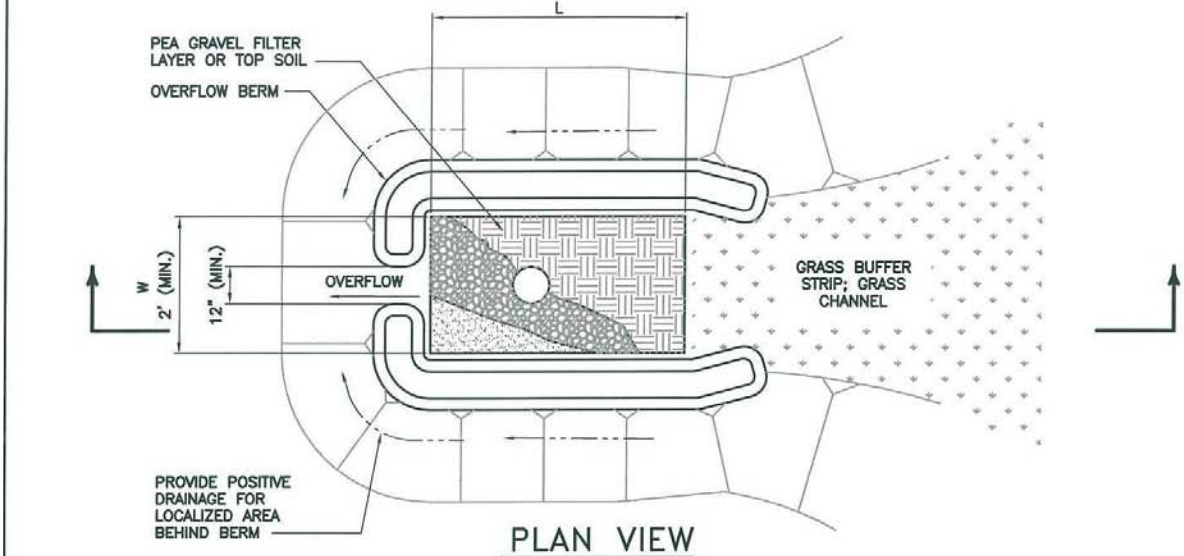
Category C—Direct Infiltration Practices

Design Checklist for Infiltration Trench

- ❒ Depth from bottom of trench to seasonally high groundwater elevation is ≥10'.
- ❒ Areas tributary to the infiltration trench do not include automotive repair shops; car washes; fleet storage areas (bus, truck, etc.); nurseries, or other uses that may present an exceptional threat to groundwater quality.
- ❒ The infiltration trench is separated by at least 100 feet from any adjacent drinking water supply wells.
- ❒ Set back from structures 10' or as required by structural or geotechnical engineer.
- ❒ Locations with high soil infiltration rates (≥2.4"/hr.) receive additional evaluation of potential effects on groundwater quality and need for pretreatment.
- ❒ Areas tributary to the infiltration trench do not exceed 5 acres.
- ❒ Infiltration rate at the bottom of the trench is 0.5 in/hr or greater. Depth to bedrock is ≥ 3'.
- ❒ All upstream drainage areas are stabilized prior to construction of the infiltration trench.
- ❒ Vegetated strip or other pretreatment has been incorporated where possible and appropriate.
- ❒ A horizontal layer of filter fabric is installed just below the surface of the trench to retain sediment and to reduce the potential for clogging.
- ❒ Trench backfill is 1.5" to 2.5" diameter clean drain rock.
- ❒ The sides of the infiltration trench are lined with a geotextile fabric.
- ❒ The infiltration trench is located a minimum of 50 feet away from slopes in excess of 15%.
- ❒ Void spaces in trench fill accommodate the required water quality volume.
- ❒ Soil infiltration rate has been confirmed (Attachment C-3).
- ❒ Bottom surface area is sufficient to ensure drainage within 72 hours.
- ❒ Design includes an observation well.



Young et al. 1996



PLAN VIEW

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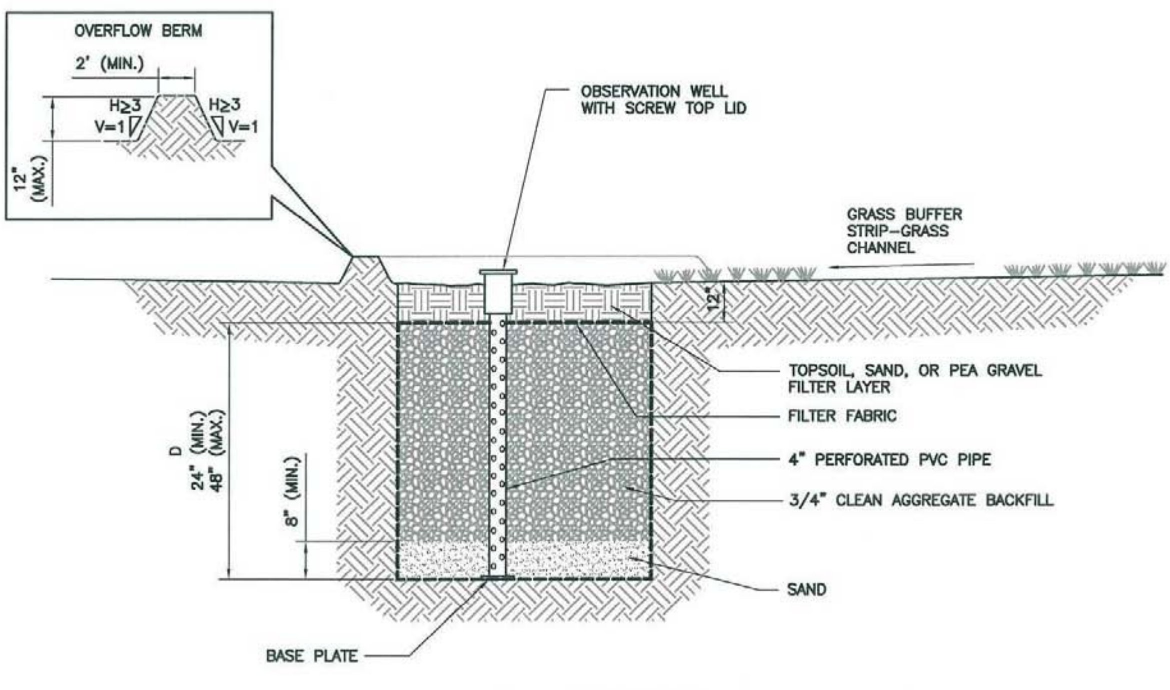

CROSS–SECTION

NOT TO SCALE

NOTE:

L = DESIGN LENGTH BASED ON DESIGN INFILTRATION VOLUME AND 3/4" CLEAN AGGREGATE VOID VOLUME.

SOURCE:
MODIFIED FROM CENTER FOR WATERSHED PROTECTION, 2000

Infiltration Trench Detail

Contra Costa Clean Water Program Infiltration Site Characterization Criteria and Guidance Study

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Attachment C-2

Example Site Screening Report

APN Query Details
Contra Costa Clean Water Program

APN		Slope Percentage Categories (Acres)				Primary Roadways (ADT > 15,000)		Water Supply Wells		Potential GW Vulnerability		Potential Soil and/or Groundwater Contamination	
Number	Area	0-2%	2-4%	4-20%	>20%	In Parcel	No. within 100 ft. of Parcel	In Parcel	No. within 100 ft. of Parcel	In Parcel	No. within 100 ft. of Parcel	In Parcel	Number of Records within 100 ft. of Parcel
561090004	214.26	92.30	6.56	28.57	86.79	No Occurence	No Occurence	---	---	not vulnerable	No Occurence	No Record	No Record

APN	Landuse Category(s)	
	Category	Area
561090004	CR	9.89
	HI	33.31
	OS	84.11
	PR	0.34
	WA	86.62

APN	Hydrologic Soil Group(s) (HSG)	
	Soilgroup	Area
561090004	C	101.03
	D	16.85
	URBAN LAND	17.83
	WATER	78.55

APN	Potential Geologic Hazards In Parcel	
	Hazard	Area
561090004	surficial deposits	22.92
	mostly landslide	39.34
	water	64.01
	few landslides	87.99

Notes:

Landuse Categories	Description *
AC	Agricultural Core
ACO	Airport Commercial
AL	Agricultural Lands
AL, OIBA	Agricultural Lands & Off Island Bonus Area
BP	Business Park
CC	Congregate Care/ Senior Housing
CO	Commercial
CR	Commercial Recreation
DR	Delta Recreation
HI	Heavy Industry
LF	Landfill
LI	Light Industry
ML, MM, MH, MV, MS	Multiple Family Residential
MO	Moblie Home
MU	Mixed Use
OF	Office
OS	Open Space
PR	Parks Recreation
PS	Public/ Semi-Public
SV, SL, SM, SH	Single Family Residential
WA	Water
WS	Watershed

* Applicability of direct infiltration methods depends on actual planned landuse activities (seeTable C-3)

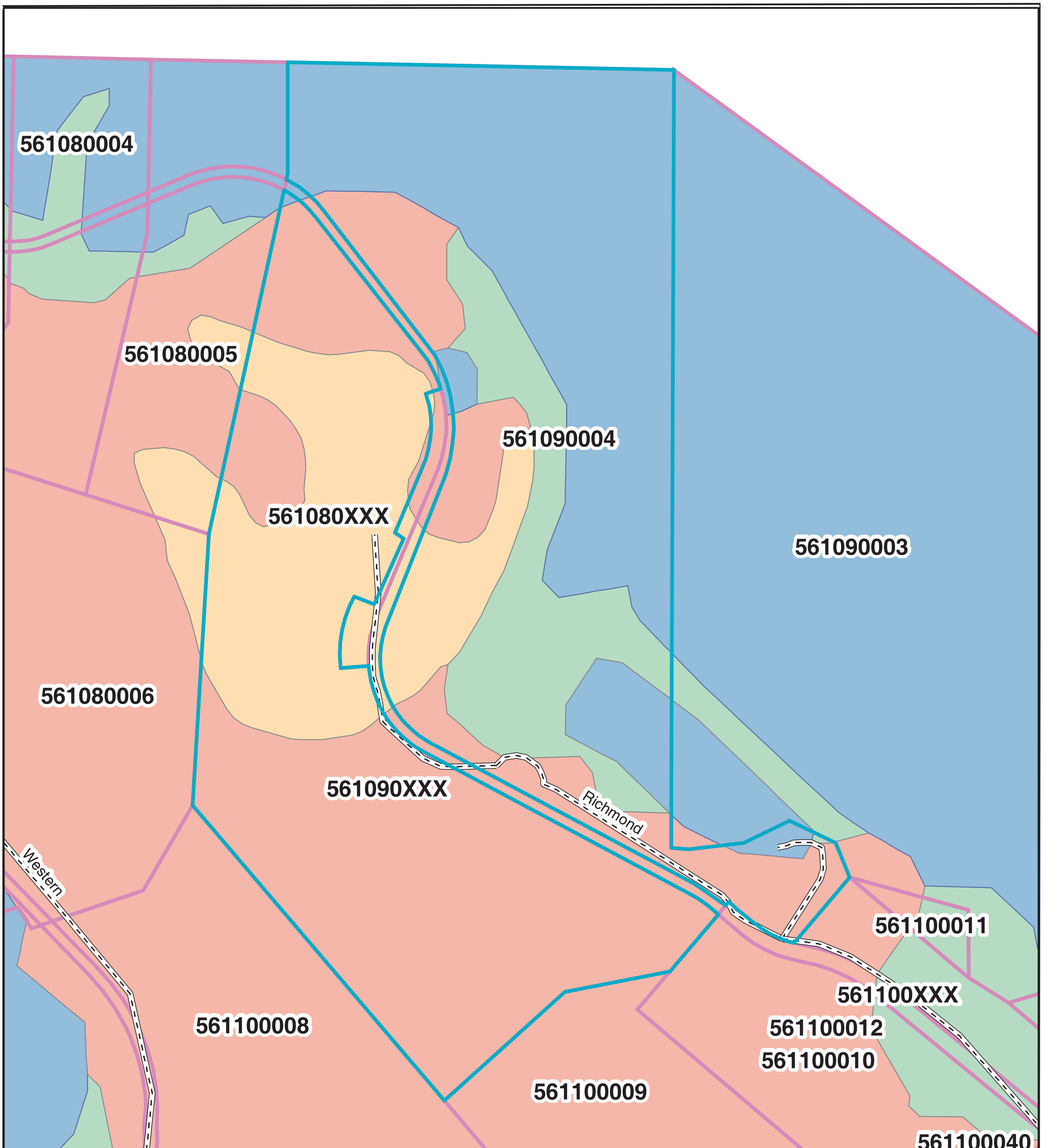
Data Source: Contra Costa County Dept. of Information Technology

Soil Group Categories	Applicability
A	generally suitable for direct infiltration
B	generally suitable for direct infiltration
C	potentially unsuitable for direct infiltration, site-specific evaluation required
D	generally unsuitable for direct infiltration
Cut and Fill Land	site-specific evaluation required
Fluvaquents	river deposits, generally suitable
Quarry	site-specific evaluation required
Rock Outcrop	site-specific evaluation required
Urban Land	site-specific evaluation required
Water	unsuitable area for stormwater infiltration

Data Source: U.S. Natural Resources Conservation Service

Geologic Hazard Categories	Applicability
Few Landslides	low-moderate risk, generally suitable
Mostly Landslide	moderate-high risk, geotechnical evaluation required
Surficial Deposits	low-moderate risk, generally suitable
Unmapped	site-specific evaluation required
Water	unsuitable area for stormwater infiltration

Data Source: U.S. Geological Survey



LEGEND

Parcel of Interest

County-wide Parcel

Contra Costa Roads

Geologic Hazards

water

unmapped

surficial deposits

mostly landslide

few landslides

Parcel Detail - Geologic Hazards
Contra Costa Clean Water Program

Contra Costa County, California

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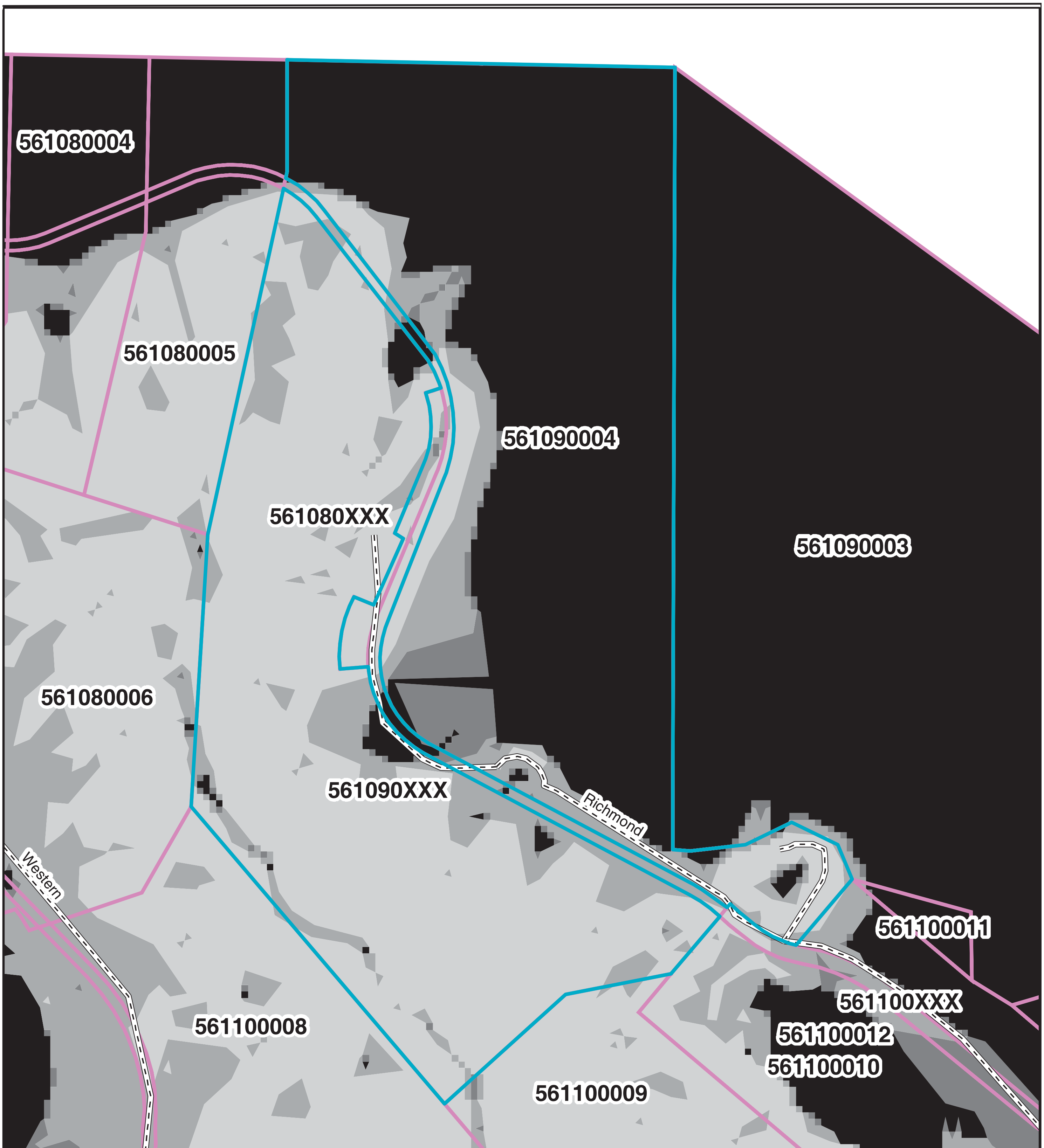

LEGEND

- Parcel of Interest
- County-wide Parcel
- Contra Costa Roads (TIGER)
- 0 - 2%
- 2 - 4%
- 4 - 20%
- >20%

Parcel Detail - Slope
Contra Costa Clean Water Program

Contra Costa County, California

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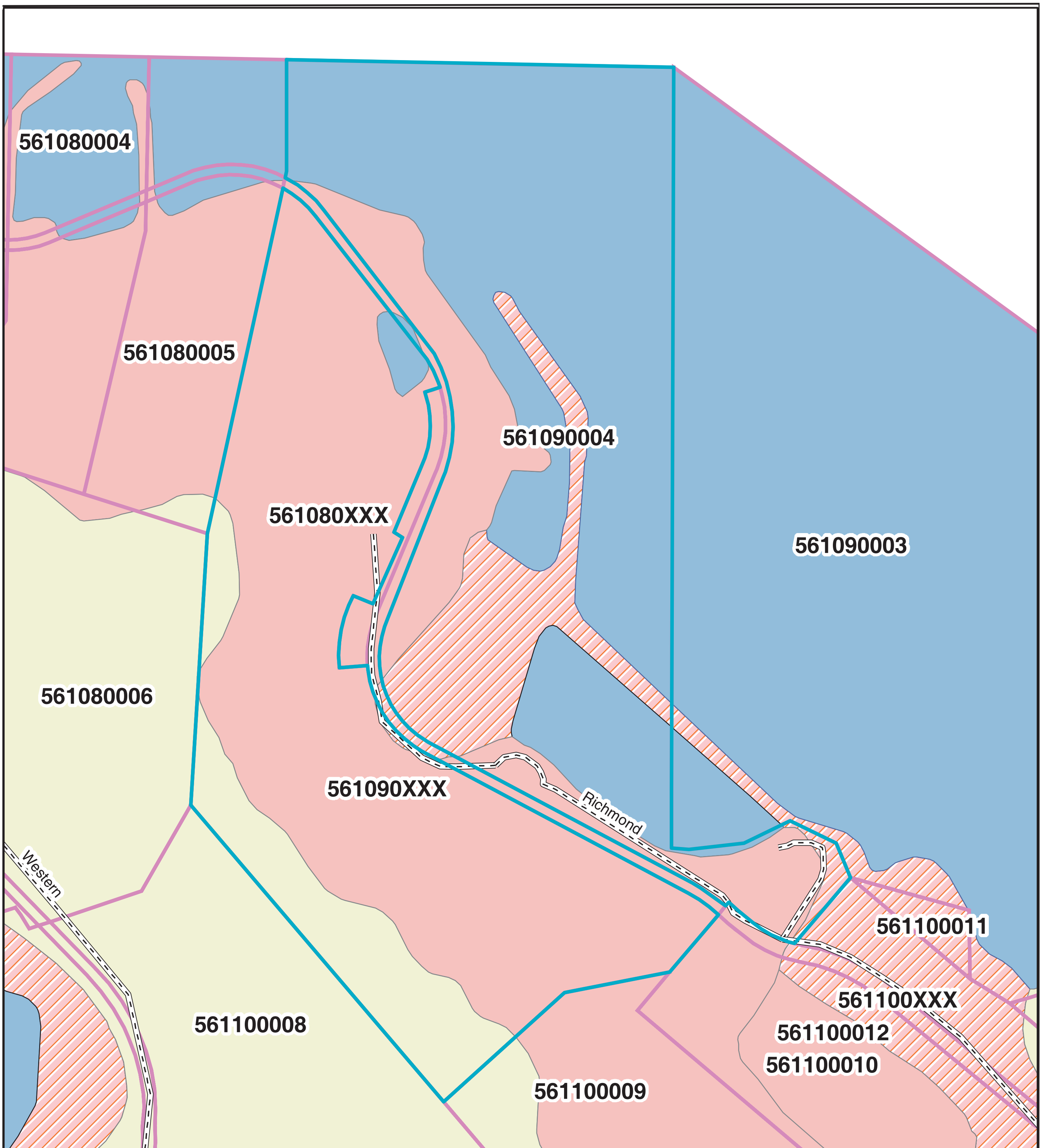

LEGEND

- County-wide Parcel
- Contra Costa Roads (TIGER)
- Parcel of Interest

Contra Costa Soils

Hydrologic Soil Group
- A
- B
- C
- D

No Hydrologic Soil Group (Soils)
- CUT AND FILL LAND-DIABLO COMPLEX
- CUT AND FILL LAND-LOS OSOS COMPLEX
- CUT AND FILL LAND-MILLSHOLM COMPLEX
- DAM
- FLUVAQUENTS
- QUARRY
- ROCK OUTCROP-XERORTHENTS ASSOCIATION
- URBAN LAND
- WATER

Parcel Detail - Soils
Contra Costa Clean Water Program

Contra Costa County, California

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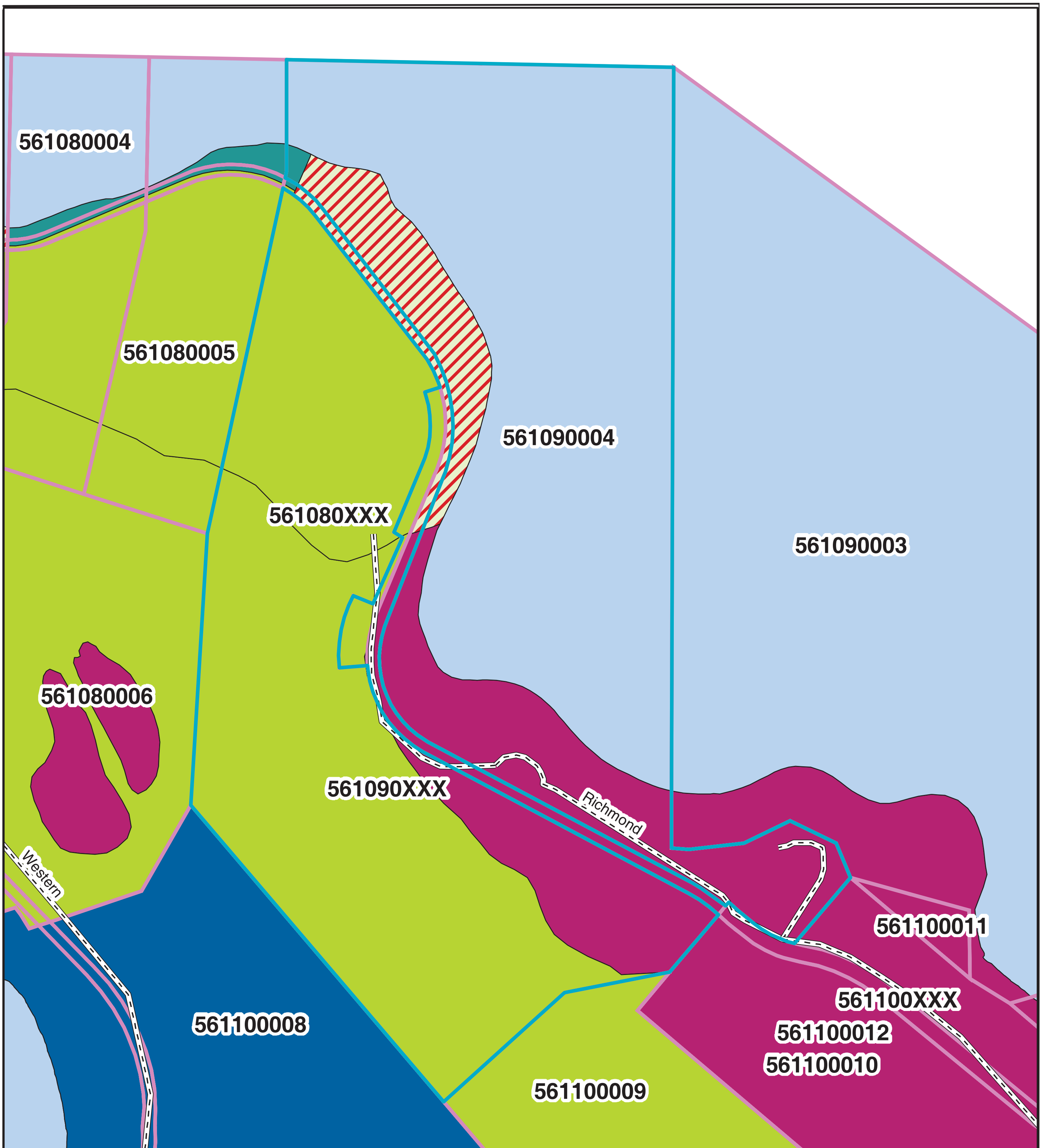

Parcel of Interest

LEGEND

- Contra Costa Roads (TIGER)
- County-wide Parcel
- M-3
- M-9
- M-7
- M-6
- M-4
- M-2
- M-1
- M-10
- M-5
- SV (Single Family Residential - Very Low)
- SL (Single Family Residential - Low)
- SM (Single Family Residential - Medium)
- SH (Single Family Residential - High)
- ML (Multiple Family Residential - Low)
- MM (Multiple Family Residential - Medium)
- MH (Multiple Family Residential - High)
- MV (Multiple Family Residential - Very High)
- MS (Multiple Family Residential - Very High Special)
- CC (Congregate Care/Senior Housing)
- MO (Mobile Home)
- CO (Commercial)
- OF (Office)
- BP (Business Park)
- LI (Light Industry)
- HI (Heavy Industry)
- AL, OIBA (Agricultural Lands & Off Island Bonus Area)
- CR (Commercial Recreation)
- ACO (Airport Commercial)
- LF (Landfill)
- MU (Mixed Use)
- PS (Public/Semi-Public)
- PR (Parks and Recreation)
- OS (Open Space)
- AL (Agricultural Lands)
- AC (Agricultural Core)
- DR (Delta Recreation)
- WA (Water)
- WS (Watershed)

Parcel Detail - Land Use
Contra Costa Clean Water Program

Contra Costa County, California

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Attachment C-3

Site Feasibility Confirmation Testing Methods

Site Feasibility Confirmation Testing

To support use of the stormwater infiltration guidance in Appendix C, a standardized soil screening and testing procedure has been developed. Standards are similar to those developed by the Wisconsin Department of Natural Resources (WDNR 2004). Alternatively, project proponents may also use similar testing methods described in the California Department of Transportation BMP Retrofit Pilot Program Final Report (CALTRANS 2004) or based on specific written recommendations provided by the local municipality's engineer.

Note: Testing is required only when the infiltration rate of native subsurface soils is used to size the infiltration device. Testing is not required for Category "B" (indirect infiltration) systems equipped with underdrains.

Initial screening identifies the potential for using infiltration methods at a site and identifies potential location on the site for infiltration devices. The purpose of the initial screening is to determine if installation of infiltration methods is feasible on the site and to determine where fieldwork may be needed for subsequent field verification.

► INITIAL SCREENING STEPS

The initial stormwater infiltration screening evaluation involves nine screening steps; the initial evaluation shall identify the following site-specific characteristics of the proposed development site:

1. Site topography and slopes greater than 20%
2. Site Hydrologic Soil Group(s) as defined in NRCS Soil Survey data
3. Presence of areas with potentially vulnerable groundwater
4. Regional or local depth to bedrock and groundwater (use seasonally high groundwater information where available)
5. Presence and/or nearby proximity to known areas with identified soil and/or groundwater contamination (existing and/or closed remediation sites and/or underground storgae tanks within or adjacent to the project parcel)
6. Relevant site land use category(s)
7. Presence of sensitive ecological habitat (including wetlands and endangered species habitat)
8. Presence of flood plains and/or flood fringes

9. Potential impact to adjacent property

► FIELD VERIFICATION

Field verification of information collected during the initial site feasibility screening process includes further investigation of specific areas on a development site that have been considered potentially suitable for infiltration. This includes verification of steps 1, 2, 3, 4, and 7.

Sites shall be tested for depth to groundwater, depth to bedrock, and percent fines to verify findings from initial screening steps. Following is a description of the percent fines expected for each type of soil textural classification.

Fill soils utilized for stormwater infiltration systems should contain a minimum of 20% fines by volume and a maximum of 40% fines by (clay and silt combined). Several textural classes are assumed to meet the minimum percent fines limitations. These classifications include sandy loams, loams, silt loams, and clay textural classifications. Coarse sand is the only soil texture that by definition will not meet the minimum limitations for a soil layer consisting of 20% fines. Other sand textures and loamy sands may need the percent fines level verified with a laboratory analysis.

Borings and pits shall be dug to verify soil infiltration capacity characteristics and to determine depth to groundwater and bedrock.

The following information shall be recorded for field verification of the initial screening:

1. The date or dates the data were collected.

2. A legible site plan/map that is presented on paper that is no less than 8½" by 11" and:

    a. Is drawn to scale or fully dimensional.

    b. Illustrates the entire development site.

    c. Shows all areas of planned filling and/or cutting.

    d. Includes a permanent vertical and horizontal reference point.

    e. Shows the percent and direction of land slope for the site or contour lines. Highlights areas with slopes over 20%.

    f. Shows all flood plain information that is pertinent to the site.

    g. Shows the locations of all pits/borings included in the report.

    h. Shows the locations of wetlands as field delineated and surveyed.

i. Shows the locations of water supply wells within 100 feet of the development site.

3. It is recommended that soil profile descriptions be written in accordance with the descriptive procedures, terminology, and interpretations found in the "USDA Field Book for Describing and Sampling Soils" (USDA NRCS 1998). In addition to the soil data determined above, soil profiles should include the following information for each soil horizon or layer:

   a. Thickness, in inches or decimal feet.

   b. Munsell soil color notation.

   c. Soil mottle or redoximorphic feature color, abundance, size, and contrast.

   d. USDA soil textural class with rock fragment modifiers.

   e. Soil structure, grade size, and shape.

   f. Soil consistence, root abundance, and size.

   g. Soil boundary.

   h. Occurrence of saturated soil, groundwater, bedrock, or disturbed soil.

► EVALUATION OF SPECIFIC INFILTRATION AREAS

This step is to determine if specific locations identified for stormwater infiltration devices are suitable for infiltration, and to provide the required information to design the device. A minimum number of borings or pits shall be constructed for each infiltration device (Table C-3-1). The following information shall be recorded for this evaluation:

1. All the information required by previous evaluation steps.

2. A legible site plan/map that is presented on paper no less than 8½" by 11" and:

   a. Is drawn to scale or fully dimensional.

   b. Illustrates the locations of the infiltration devices.

   c. Shows the locations of all pits and borings.

   d. Shows distance from device to wetlands.

3. One of the following methods shall be used to determine the design infiltration rate:

   a. Infiltration Rate Not Measured - Table C-3-2 shall be used if the infiltration rate is not measured. Select the design infiltration rate from Table C-3-2 based on the least permeable soil horizon 5 feet below the bottom elevation of the infiltration system.

   b. Measured Infiltration Rate - The tests shall be conducted at the proposed bottom elevation of the infiltration device. The standardized infiltration test pit/boring requirements and the standard testing protocol is described below.

      To select the correction factor from Table C-3-3, the ratio of design infiltration rates must be determined for each place an infiltration measurement is taken. The design infiltration rates from Table C-3-3 are used to calculate the ratio. To determine the ratio, the design infiltration rate for the surface textural classification is divided by the design infiltration rate for the least permeable soil horizon. For example, a device with loamy sand at the surface and a least permeable layer of loam will have a design infiltration rate ratio of about 6.8 and a correction factor of 4.5. The depth of the least permeable soil horizon (a limiting layer) should be identified within 5 feet of the proposed bottom of the proposed infiltration facility.

      Final infiltration testing data shall be documented, and include a description of the infiltration testing method. This is to ensure that the tester and reviewer fully understand the procedure.

► STANDARDIZED TEST PIT/BORING REQUIREMENTS

Boring is required in the infiltration facility area to a minimum depth of 5 feet below the proposed bottom of the facility (i.e., trench). Infiltration is not feasible if evidence of groundwater or bedrock/hard pan is within 5 feet of proposed bottom of facility. The following steps describe the main elements necessary to support test pit/boring requirements:

1. Excavate a test pit or dig a standard soil boring to a depth of approximately 3 feet below the proposed facility bottom.

2. Determine depth to groundwater table (if potentially within the top 10 feet below the existing ground surface).

3. Conduct Standard Penetration Testing (SPT) every 1 foot to a depth of 3 feet below the facility bottom.

4. Determine US Department of Agriculture (USDA) or Unified Soil Classification (USC) System textures at the proposed bottom and 3 feet below the bottom of the infiltration system.

5. Describe soil horizons and determine depth to bedrock (if within 3 feet of proposed bottom of facility).

6. The location of the test pit or boring shall correspond to the BMP location; test pit/soil boring stakes are to be left in the field for inspection purposes and shall be clearly labeled as such.

► STANDARDIZED INFILTRATION TESTING PROTOCOL

At least two (2) soil permeability tests are typically required or as an absolute minimum one (1) test is required for every 5,000 square feet (s.f.) of infiltration system bottom area. The soil test(s) must be taken at the proposed bottom of the infiltration system. The test location must not be more than 20 feet from the final location of the infiltration system. Test location(s) should be located/identified on plans, to be verified by field observation. The following protocol provides an accepted procedure for conducting bore hole infiltration tests. A similar acceptable protocol is described in the California Department of Transportation BMP Retrofit Pilot Program Final Report (CALTRANS 2004). Alternatively, if the infiltration rate is measured with a *Double-Ring Infiltrometer* the requirements of ASTM D3385 shall be used for the field test.

1. Install casing to a minimum of 2.0 feet below proposed BMP bottom.

2. Remove any smeared soiled surfaces and provide a natural soil interface into which water may percolate. Remove all loose material from the casing. Upon the tester's discretion, a layer of coarse sand or fine gravel may be placed to protect the bottom from scouring and sediment. Fill casing with clean water to a depth of 2.0 feet and allow to pre-soak for 24 hours.

3. Twenty-four hours later, refill casing with another 2.0 feet of clean water and monitor water level (measured drop from the top of the casing) for 1 hour. Repeat this procedure (filling the casing each time) three additional times, for a total of four observations. Upon the tester's discretion, the final field rate may either be the average of the four observations, or the value of the last observation. The final rate shall be reported in inches per hour.

4. May be done through a boring or open excavation.

5. The location of the test shall correspond to the BMP location.

6. Upon completion of the testing, the casings shall be pulled and the test pit shall be backfilled.

7. For infiltration trench and basin practices, a minimum field infiltration rate of 0.5 inch/hour is typically required; areas yielding a lower rate preclude these practices without special considerations. For bioretention practices and vegetated swales, no minimum infiltration rate is required if these facilities are designed with a "day-lighting" underdrain system and with permeable soils having less than 20 percent fines (clay and/or silt particles).

8. Number of required borings is based on the size of the proposed infiltration facility. (At least one test per 5,000 square feet of infiltration bottom area)

9. Testing is to be conducted by a qualified professional. This professional shall either be a registered professional engineer, a soils scientist, or geologist licensed in California.

Table C-3-1. Evaluation Requirements Specific to Proposed Infiltration Devices

Infiltration Device	*Tests Required*[1]	*Minimum Number of Borings/Pits Required*	*Minimum Drill/Test Depth Required Below the Bottom of the Infiltration System*
Irrigation Systems[2], *Rain Gardens*[2], *Green Roofs*[2]	NA[2]	NA[2]	NA[2]
Infiltration Trenches (≤2,000 square feet of impervious drainage area)	Pits, borings, or double- ring infiltrometer	1 test/100 linear feet of trench	5 feet or depth to limiting layer, whichever is less
Infiltration Trenches (>2,000 square feet of impervious drainage area)	Pits, borings, or double- ring infiltrometer	1 pit required and an additional 1 pit or boring/ 100 linear feet of trench	Pits to 5 feet or depth to limiting layer. Borings to 15 feet or depth to limiting layer
Bioretention Systems	Pits, borings, or double- ring infiltrometer	Minimum of 1 test per 5,000 s.f. of infiltration bottom area	5 feet or depth to limiting layer
Infiltration/Dry Vegetated Swales	Pits, borings, or double- ring infiltrometer	1 test/1,000 linear feet of swale or, 1 test per 5,000 s.f. of infiltration bottom area	5 feet or depth to limiting layer
Surface Infiltration Basins	Pits, borings, or double- ring infiltrometer	Minimum of 1 test per 5,000 s.f. of infiltration bottom area	Pits to 10 feet or depth to limiting layer. Borings to 20 feet or depth to limiting layer
Subsurface Dispersal Systems (i.e. dry wells)	Pits, borings, or double- ring infiltrometer	Minimum of 1 test per 5,000 s.f. of infiltration bottom area	Pits to 10 feet or depth to limiting layer. Borings to 20 feet or depth to limiting layer

Notes:

1. Continuous soil borings shall be taken using a bucket auger, probe, split-spoon sampler, or shelby tube. Samples shall have a minimum 2-inch diameter. Soil pits must be of adequate size, depth, and construction to allow a person to enter and exit the pit and complete a morphological soil profile description.
2. Information from the initial stormwater infiltration screening steps is adequate to design rain gardens and irrigation systems.

Table C-3-2. Design Infiltration Rates for Soil Textures Receiving Stormwater

Soil Texture1	*Design Infiltration Rate Without Measurement inches/hour2*
Coarse sand or coarser	3.60
Loamy coarse sand	3.60
Sand	3.60
Loamy sand	1.63
Sandy loam	0.50
Loam	0.24
Silt loam	0.13
Sandy clay loam	0.11
Clay loam	0.03
Silty clay loam	0.043
Sandy clay	0.04
Silty clay	0.07
Clay	0.07

Notes:

1. Use sandy loam design infiltration rates for fine sand, loamy fine sand, very fine sand, and loamy fine sand soil textures.
2. Infiltration rates represent the lowest value for each textural class presented in Table 2 of Rawls, 1998.
3. Infiltration rate is an average based on Rawls, 1982, and Clapp & Hornberger, 1978.

Table C-3-3. Total Correction Factors Divided into Measured Infiltration Rates

Ratio of Design Infiltration Rates1	Correction Factor
1	2.5
1.1 to 4.0	3.5
4.1 to 8.0	4.5
8.1 to 16.0	6.5
16.1 or greater	8.5

Note:

1. Ratio is determined by dividing the design infiltration rate (Table C-3-2) for the textural classification at the bottom of the infiltration device by the design infiltration rate (Table C-3-2) for the textural classification of the least permeable soil horizon. The least permeable soil horizon used for the ratio should be within 5 feet of the bottom of the device or to the depth of the limiting layer.

Appendix

D

Hydrograph Modification Management Guidance

Detailed instructions and tools for sizing hydrograph modification management BMPs.

[The Program's Hydrograph Modification Management Plan is due to be completed in May 2005. Check www.cccleanwater.org/construction/nd.php for updates.]

Appendix

E

Pollutant Sources/Source Control Checklist

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

How to use this worksheet (also see instructions on pages 29-30 of the *Stormwater C.3 Guidebook*):

1. Review Column 1 and identify which of these potential sources of stormwater pollutants apply to your site. Check each box that applies.
2. Review Column 2 and incorporate all of the corresponding applicable BMPs in your Stormwater Control Plan drawings.
3. Review Columns 3 and 4 and incorporate all of the corresponding applicable permanent controls and operational BMPs in a table in your Stormwater Control Plan. Use the format shown in Table 3-1 on page 30 of the *Guidebook*. Describe your specific BMPs in an accompanying narrative, and explain any special conditions or situations that required omitting BMPs or substituting alternative BMPs for those shown here.

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
❑ A. **On-site storm drain inlets**	❑ **Locations of inlets.**	❑ **Mark all inlets with the words "No Dumping! Flows to Bay" or similar.**	❑ **Maintain and periodically repaint or replace inlet markings.** ❑ **Provide stormwater pollution prevention information to new site owners, lessees, or operators.** ❑ **See applicable operational BMPs in Fact Sheet SC-44, "Drainage System Maintenance," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com** ❑ **Include the following in lease agreements: "Tenant shall not allow anyone to discharge anything to storm drains or to store or deposit materials so as to create a potential discharge to storm drains."**

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
❑ B. **Interior floor drains and elevator shaft sump pumps**		❑ **State that interior floor drains and elevator shaft sump pumps will be plumbed to sanitary sewer.**	❑ **Inspect and maintain drains to prevent blockages and overflow.**
❑ C. **Interior parking garages**		❑ **State that parking garage floor drains will be plumbed to the sanitary sewer.**	❑ **Inspect and maintain drains to prevent blockages and overflow.**
❑ D1. **Need for future indoor & structural pest control**		❑ **Note building design features that discourage entry of pests.**	❑ **Provide Integrated Pest Management information to owners, lessees, and operators.**

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE …	… THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
❑ D2. **Landscape/ Outdoor Pesticide Use**	❑ **Show locations of native trees or areas of shrubs and ground cover to be undisturbed and retained.** ❑ **Show self-retaining landscape areas, if any.** ❑ **Show stormwater treatment and hydrograph modification management BMPs. (See instructions in Chapter 3, Step 5 and guidance in Chapter 5.)**	**State that final landscape plans will accomplish all of the following.** ❑ **Preserve existing native trees, shrubs, and ground cover to the maximum extent possible.** ❑ **Design landscaping to minimize irrigation and runoff, to promote surface infiltration where appropriate, and to minimize the use of fertilizers and pesticides that can contribute to stormwater pollution.** ❑ **Where landscaped areas are used to retain or detain stormwater, specify plants that are tolerant of saturated soil conditions.** ❑ **Consider using pest-resistant plants, especially adjacent to hardscape.** ❑ **To insure successful establishment, select plants appropriate to site soils, slopes, climate, sun, wind, rain, land use, air movement, ecological consistency, and plant interactions.**	❑ **Maintain landscaping using minimum or no pesticides.** ❑ **See applicable operational BMPs in Fact Sheet SC-41, "Building and Grounds Maintenance," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com** ❑ **Provide IPM information to new owners, lessees and operators.**
❑ E. **Pools, spas, ponds, decorative fountains, and other water features.**	❑ **Show location of water feature and a sanitary sewer cleanout in an accessible area within 10 feet. (Exception: Public pools must be plumbed according to County Department of Environmental Health Guidelines.)**	**If the local municipality requires pools to be plumbed to the sanitary sewer, place a note on the plans and state in the narrative that this connection will be made according to local requirements.**	❑ **See applicable operational BMPs in Fact Sheet SC-72, "Fountain and Pool Maintenance," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
❑ F. **Food service**	❑ **For restaurants, grocery stores, and other food service operations, show location (indoors or in a covered area outdoors) of a floor sink or other area for cleaning floor mats, containers, and equipment.** ❑ **On the drawing, show a note that this drain will be connected to a grease interceptor before discharging to the sanitary sewer.**	❑ **Describe the location and features of the designated cleaning area.** ❑ **Describe the items to be cleaned in this facility and how it has been sized to insure that the largest items can be accommodated.**	❑ **See the brochure, "Water Pollution Prevention Tips to Protect Water Quality and Keep Your Food Service Facility Clean." Provide this brochure to new site owners, lessees, and operators.**
❑ G. **Refuse areas**	❑ **Show where site refuse and recycled materials will be handled and stored for pickup. See local municipal requirements for sizes and other details of refuse areas.** ❑ **If dumpsters or other receptacles are outdoors, show how the designated area will be covered, graded, and paved to prevent run-on and show locations of berms to prevent runoff from the area.** ❑ **Any drains from dumpsters, compactors, and tallow bin areas shall be connected to a grease removal device before discharge to sanitary sewer.**	❑ **State how site refuse will be handled and provide supporting detail to what is shown on plans.** ❑ **State that signs will be posted on or near dumpsters with the words "Do not dump hazardous materials here" or similar.**	❑ **State how the following will be implemented:** **Provide adequate number of receptacles. Inspect receptacles regularly; repair or replace leaky receptacles. Keep receptacles covered. Prohibit/prevent dumping of liquid or hazardous wastes. Post "no hazardous materials" signs. Inspect and pick up litter daily and clean up spills immediately. Keep spill control materials available on-site. See Fact Sheet SC-34, "Waste Handling and Disposal" in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
❑ H. **Industrial processes.**	❑ Show process area.	❑ If industrial processes are to be located on site, state: "All process activities to be performed indoors. No processes to drain to exterior or to storm drain system."	❑ See Fact Sheet SC-10, "Non-Stormwater Discharges" in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com
❑ I. **Outdoor storage of equipment or materials.** (See rows J and K for source control measures for vehicle cleaning, repair, and maintenance.)	❑ Show any outdoor storage areas, including how materials will be covered. Show how areas will be graded and bermed to prevent run-on or run-off from area. ❑ Storage of non-hazardous liquids shall be covered by a roof and/or drain to the sanitary sewer system, and be contained by berms, dikes, liners, or vaults. ❑ Storage of hazardous materials and wastes must be in compliance with the local hazardous materials ordinance and a Hazardous Materials Management Plan for the site.	Include a detailed description of materials to be stored, storage areas, and structural features to prevent pollutants from entering storm drains. Where appropriate, reference documentation of compliance with the requirements of Contra Costa Hazardous Materials Programs for: ▪ Hazardous Waste Generation ▪ Hazardous Materials Release Response and Inventory ▪ California Accidental Release (CalARP) ▪ Aboveground Storage Tank ▪ Uniform Fire Code Article 80 Section 103(b) & (c) 1991 ▪ Underground Storage Tank www.cchealth.org/groups/hazmat/	❑ See the Fact Sheets SC-31, "Outdoor Liquid Container Storage" and SC-33, "Outdoor Storage of Raw Materials " in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
❑ J. **Vehicle and Equipment Cleaning**	❑ **Show on drawings as appropriate:** **(1) Commercial/industrial facilities having vehicle/equipment cleaning needs shall either provide a covered, bermed area for washing activities or discourage vehicle/equipment washing by removing hose bibs and installing signs prohibiting such uses.** **(2) Multi-dwelling complexes shall have a paved, bermed, and covered car wash area (unless car washing is prohibited on-site and hoses are provided with an automatic shut-off to discourage such use).** **(3) Washing areas for cars, vehicles, and equipment shall be paved, designed to prevent run-on to or runoff from the area, and plumbed to drain to the sanitary sewer.** **(4) Commercial car wash facilities shall be designed such that no runoff from the facility is discharged to the storm drain system. Wastewater from the facility shall discharge to the sanitary sewer, or a wastewater reclamation system shall be installed.**	❑ **If a car wash area is not provided, describe measures taken to discourage on-site car washing and explain how these will be enforced.**	**Describe operational measures to implement the following (if applicable):** ❑ **Washwater from vehicle and equipment washing operations shall not be discharged to the storm drain system.** ❑ **Car dealerships and similar may rinse cars with water only.** **See Fact Sheet SC-21, "Vehicle and Equipment Cleaning," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

<table>
<tr><td>IF THESE SOURCES WILL BE ON THE PROJECT SITE ...</td><td colspan="3">... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs</td></tr>
<tr><td>1
Potential Sources of Runoff Pollutants</td><td>2
Permanent Controls—Show on Stormwater Control Plan Drawings</td><td>3
Permanent Controls—List in Stormwater Control Plan Table and Narrative</td><td>4
Operational BMPs—Include in Stormwater Control Plan Table and Narrative</td></tr>
<tr><td>❑ K. Vehicle/Equipment Repair and Maintenance</td><td>❑ Accommodate all vehicle equipment repair and maintenance indoors. Or designate an outdoor work area and design the area to prevent run-on and runoff of stormwater.
❑ Show secondary containment for exterior work areas where motor oil, brake fluid, gasoline, diesel fuel, radiator fluid, acid-containing batteries or other hazardous materials or hazardous wastes are used or stored. Drains shall not be installed within the secondary containment areas.
❑ Add a note on the plans that states either (1) there are no floor drains, or (2) floor drains are connected to wastewater pretreatment systems prior to discharge to the sanitary sewer and an industrial waste discharge permit will be obtained.</td><td>❑ State that no vehicle repair or maintenance will be done outdoors, or else describe the required features of the outdoor work area.
❑ State that there are no floor drains or if there are floor drains, note the agency from which an industrial waste discharge permit will be obtained and that the design meets that agency's requirements.
❑ State that there are no tanks, containers or sinks to be used for parts cleaning or rinsing or, if there are, note the agency from which an industrial waste discharge permit will be obtained and that the design meets that agency's requirements.</td><td>In the Stormwater Control Plan, note that all of the following restrictions apply to use the site:
❑ No person shall dispose of, nor permit the disposal, directly or indirectly of vehicle fluids, hazardous materials, or rinsewater from parts cleaning into storm drains.
❑ No vehicle fluid removal shall be performed outside a building, nor on asphalt or ground surfaces, whether inside or outside a building, except in such a manner as to ensure that any spilled fluid will be in an area of secondary containment. Leaking vehicle fluids shall be contained or drained from the vehicle immediately.
❑ No person shall leave unattended drip parts or other open containers containing vehicle fluid, unless such containers are in use or in an area of secondary containment.</td></tr>
</table>

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
❑ L. **Fuel Dispensing Areas**	❑ **Fueling areas[1] shall have impermeable floors (i.e., portland cement concrete or equivalent smooth impervious surface) that are: a) graded at the minimum slope necessary to prevent ponding; and b) separated from the rest of the site by a grade break that prevents run-on of stormwater to the maximum extent practicable.** ❑ **Fueling areas shall be covered by a canopy that extends a minimum of ten feet in each direction from each pump. [Alternative: The fueling area must be covered and the cover's minimum dimensions must be equal to or greater than the area within the grade break or fuel dispensing area[1].] The canopy [or cover] shall not drain onto the fueling area.**		❑ **The property owner shall dry sweep the fueling area routinely.** ❑ **See the Business Guide Sheet, "Automotive Service—Service Stations" in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**

[1] **The fueling area shall be defined as the area extending a minimum of 6.5 feet from the corner of each fuel dispenser or the length at which the hose and nozzle assembly may be operated plus a minimum of one foot, whichever is greater.**

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE …	… THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
❑ M. **Loading Docks**	❑ **Show a preliminary design for the loading dock area, including roofing and drainage. Loading docks shall be covered and/or graded to minimize run-on to and runoff from the loading area. Roof downspouts shall be positioned to direct stormwater away from the loading area. Water from loading dock areas shall be drained to the sanitary sewer, or diverted and collected for ultimate discharge to the sanitary sewer.** ❑ **Loading dock areas draining directly to the sanitary sewer shall be equipped with a spill control valve or equivalent device, which shall be kept closed during periods of operation.** ❑ **Provide a roof overhang over the loading area or install door skirts (cowling) at each bay that enclose the end of the trailer.**		❑ **Move loaded and unloaded items indoors as soon as possible.** ❑ **See Fact Sheet SC-30, "Outdoor Loading and Unloading," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**
❑ N. **Fire Sprinkler Test Water**		❑ **Provide a means to drain fire sprinkler test water to the sanitary sewer.**	❑ **See the note in Fact Sheet SC-41, "Building and Grounds Maintenance," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
O. **Miscellaneous Drain or Wash Water** ❑ **Boiler drain lines** ❑ **Condensate drain lines** ❑ **Rooftop equipment** ❑ **Drainage sumps** ❑ **Roofing, gutters, and trim.**		❑ **Boiler drain lines shall be directly or indirectly connected to the sanitary sewer system and may not discharge to the storm drain system.** ❑ **Condensate drain lines may discharge to landscaped areas if the flow is small enough that runoff will not occur. Condensate drain lines may not discharge to the storm drain system.** ❑ **Rooftop mounted equipment with potential to produce pollutants shall be roofed and/or have secondary containment.** ❑ **Any drainage sumps on-site shall feature a sediment sump to reduce the quantity of sediment in pumped water.** ❑ **Avoid roofing, gutters, and trim made of copper or other unprotected metals that may leach into runoff.**	
❑ P. **Plazas, sidewalks, and parking lots.**			❑ **Plazas, sidewalks, and parking lots shall be swept regularly to prevent the accumulation of litter and debris. Debris from pressure washing shall be collected to prevent entry into the storm drain system. Washwater containing any cleaning agent or degreaser shall be collected and discharged to the sanitary sewer and not discharged to a storm drain.**

Appendix

F

Preparing Your Stormwater Control Operation & Maintenance Plan

How to prepare a customized Stormwater Control Operation & Maintenance Plan for the treatment BMPs on your site.

Stormwater treatment BMPs must be regularly maintained to ensure that they continue to be effective and that they do not cause flooding, harbor vectors, or otherwise create a nuisance.

Stormwater NPDES Permit Provision C.3.e requires each municipality verify that treatment BMPs are being adequately maintained. The Program reports the results of BMP inspections to the Regional Water Quality Control Board (Water Board) annually.

This Appendix will assist you to prepare a customized Operation and Maintenance (O&M) Plan for your site.

Appendix F Contents

ICON KEY

- Helpful Tip
- Submittal Requirement
- Terms to Look Up
- References & Resources

Submit a draft O&M Plan with construction documents when you apply for permits to begin grading or construction on the site. Revise your draft O&M plan in response to any comments from your municipality, and incorporate new information and changes developed during project construction. Submit a revised, final O&M plan before construction is complete.

Your Final Stormwater Control O&M Plan must be submitted to and approved by your municipality before your building permit can be made final and a certificate of occupancy issued.

Local Requirements

Cities, towns, or the County may have requirements that differ from, or are in addition to, this countywide Guidebook. See Appendix A for local requirements, and see Appendix K for a description of the local BMP Operation and Maintenance Verification Program.

Your O&M Plan must be kept on-site for use by maintenance personnel and during site inspections. It is also recommended that a copy of the Stormwater Control Plan be kept onsite as a reference.

Verification Program Overview

Chapter Six describes a six-stage process for incorporating the treatment BMPs on your site into your municipality's treatment BMP operation and maintenance verification program. The stages are as follows:

1. Applicants for planning and zoning approval must confirm, in their Stormwater Control Plan, responsibility for operating and maintaining BMPs until that responsibility is transferred.

2. The Stormwater Control Plan includes locations, types, and sizes of proposed treatment BMPs and general information about their operation and maintenance requirements.

3. Following approval of their planning and zoning application, applicants for building permits prepare a Stormwater Control Operation and Maintenance Plan. A draft O&M Plan must be submitted with the building permit application. A final O&M Plan must be submitted for review and approved by the municipality prior to building permit final and issuance of a certificate of occupancy.

4. Treatment BMPs must be maintained during site preparation and construction.

5. You must notify the municipality when responsibility for BMP operation and maintenance is transferred to the property owner or occupant. Your municipality may require a Stormwater Management Facilities Operation and Maintenance Agreement. The standard agreement is Attachment 1 to this Appendix and may also be found on

the Program's web site. The agreement runs with the land, and future property owners are obligated to implement its provisions.

6. Property owners must inspect and maintain BMPs throughout the year—periodically and following storms—according to the schedule in their approved Stormwater Control Operation and Maintenance Plan.

► ANNUAL CERTIFICATE OF COMPLIANCE

The NPDES permit requires municipalities to inspect a subset of prioritized treatment measures each year. Municipalities may require that property owners (or their lessees) obtain an annual certificate of compliance certifying appropriate operation and maintenance of BMPs on their site.

To obtain a certificate of compliance, the responsible party must request and pay for an inspection from the municipality each year. The municipality will inspect the property and may:

1. Issue a certificate,
2. Issue a conditional certificate requiring correction of noted deficiencies by a specific date, or
3. Deny the certificate.

Alternatively, owners (or lessees) may arrange for inspection by a private company authorized by the municipality.

See Chapter Six for a detailed description of the process for planning treatment BMP operation and maintenance.

Local Requirements

Cities, towns, or the County may have requirements that differ from, or are in addition to, this countywide Guidebook. See Appendix A for local requirements, and see Appendix K for a description of the local BMP Operation and Maintenance Verification Program.

Stormwater Control O&M Plan Overview

► PURPOSES AND USERS

Your Stormwater Control O&M Plan should:

- Document the design parameters, features, methods and materials of construction, intended mode of operation, and other key characteristics of stormwater treatment BMPs on your site.
- Set forth a detailed maintenance program and schedule to ensure that treatment BMPs continue to operate as intended.
- Anticipate potential problems or failures and provide instructions for troubleshooting.

- Provide a reference and checklists to be used during verification inspections.

The primary audience for your O&M Plan is facility maintenance staff, including those responsible for supervising landscape and/or mechanical maintenance. The focus should be on creating easy-to-follow step-by-step instructions for implementing and documenting maintenance activities.

The secondary audience is municipal staff, Water Board staff, and others who may be responsible for verifying maintenance.

► CONTENTS

Your O&M Plan should follow this general outline:

I. Inspection and Maintenance Log (Attachment F-3)

II. Updates, Revisions and Errata

III. Introduction

 A. Narrative overview describing the site; drainage areas, routing, and discharge points; and treatment BMPs

IV. Responsibility for Maintenance

 A. General

  (1) Name and contact information for responsible individual(s).

  (2) Organization chart or charts showing organization of the maintenance function and location within the overall organization.

  (3) Reference to Operation and Maintenance Agreement (if any). A copy of the agreement should be attached.

  (4) Maintenance Funding

   (a) Sources of funds for maintenance

   (b) Budget category or line item

   (c) Description of procedure and process for ensuring adequate funding for maintenance

 B. Staff Training Program

 C. Records

 D. Safety

V. Summary of Drainage Areas and BMPs

A. Drainage Areas

(1) Drawings showing pervious and impervious areas (copied or adapted from Stormwater Control Plan)

(2) Designation and description of each drainage area and how flow is routed to the corresponding BMP.

B. Treatment BMPs

(1) Drawings showing location and type of each BMP

(2) General description of each BMP (Consider a table if more than two BMPs)

(a) Area drained and routing of discharge.

(b) BMP type and size

VI. BMP Design Documentation

A. "As-built" drawings of each BMP (design drawings in the draft Plan)

B. Manufacturer's data, manuals, and maintenance requirements for pumps, mechanical or electrical equipment, and proprietary BMPs (include a "placeholder" in the draft plan for information not yet available).

C. Specific operation and maintenance concerns and troubleshooting

VII. BMP Maintenance Schedule

A. Summary Annual Maintenance Schedule for All BMPs (combined)

B. Inspection and Maintenance Schedule for Each BMP (see Step 4 below), including checklists for:

(1) Routine inspection and maintenance

(2) Annual inspection and maintenance

(3) Inspection and maintenance after major storms

C. Service Agreement Information

Tools and Assistance

The following step-by-step instructions and attached forms will help you prepare your Stormwater Control Operation and Maintenance Plan. You may use, adapt, and assemble these documents to prepare your own Plan which will be customized to the specific needs of your site.

These include:

- A standard "Stormwater Management Facilities Operation and Maintenance Agreement" (Attachment 1).
- A form for stating or updating key contact information (Attachment 2).
- An example Inspection and Maintenance Log (Attachment 3).
- A format for an independent inspector's annual inspection report (Attachment 4).
- O&M Fact Sheets, developed by the California Stormwater Quality Association for 15 BMPs (available in the Municipal Handbook at www.cabmphandbooks.org) and O&M Fact Sheets for 6 additional BMPs developed by the Santa Clara Valley Urban Runoff Pollution Prevention Program (www.scvurppp.org).
- Additional useful references, including links to additional documents available on the web (in the bibliography).

Step by Step

The following step-by-step guidance will help you prepare each required section of your Stormwater Control Operation and Maintenance Plan.

Preparation of the plan will require familiarity with your BMPs as they have been constructed and a fair amount of "thinking through" plans for their operation and maintenance. The text and forms provided here will assist you, but are no substitute for thoughtful planning.

1: Responsible Individuals

► DESIGNATE RESPONSIBLE INDIVIDUALS

To begin creating your O&M Plan, your organization must designate and identify:

- The individual who will have direct responsibility for the maintenance of stormwater controls. This individual should be the designated contact with municipal inspectors and should sign self-inspection reports and any correspondence with the municipality regarding verification inspections.

- Employees or contractors who will report to the designated contact and are responsible for carrying out BMP operation and maintenance.
- The corporate officer authorized to negotiate and execute any contracts that might be necessary for future changes to operation and maintenance or to implement remedial measures if problems occur.
- Your designated respondent to problems, such as clogged drains or broken irrigation mains, that would require immediate response should they occur during off-hours.

► LIST CONTACT INFORMATION

List the contact information for each designee on the form provided (Attachment 2). Include this form directly in Section 2 of your O&M Plan.

Updated contact information must be provided to the municipality immediately whenever a property is sold and whenever designated individuals or contractors change.

Complete a new Attachment 2 and add it to Section 1—and mail or fax a copy to the municipality—whenever this occurs.

► ORGANIZATION CHART

Draw or sketch an organization chart to show the relationships of authority and responsibility between the individuals responsible for O&M. This need not be elaborate, particularly for smaller organizations.

► FUNDING FOR OPERATION AND MAINTENANCE

Describe how funding for BMP operation and maintenance will be assured, including sources of funds, budget category for expenditures, process for establishing the annual maintenance budget, and process for obtaining authority should unexpected expenditures for major corrective maintenance be required.

► STAFF OR CONTRACTOR TRAINING

Describe how your organization will accommodate initial training of staff or contractors regarding the purpose, mode of operation, and maintenance requirements for the BMPs on your site. Also, describe how your organization will ensure ongoing training as needed and in response to staff changes.

2: Summarize Drainage and BMPs

Your Stormwater Control Plan, prepared and submitted with the planning and zoning application for your project, contains information that will be needed for maintenance or future renovation of the BMPs on your site.

Incorporate the following into your O&M Plan:

- Figures delineating and designating pervious and impervious areas.
- Figures showing locations of BMPs on the site.
- Tables of pervious and impervious areas served by each BMP.

Review the Stormwater Control Plan narrative that describes each BMP and its tributary drainage area and update the text to incorporate any changes that may have occurred during planning and zoning review, building permit review, or construction. Incorporate the updated text into your O&M Plan.

3: Document BMPs "As Built"

Include the following information from final construction drawings:

- Plans, elevations, and details of all BMPs. Annotate if necessary with designations used in the Stormwater Control Plan.
- Design information or calculations submitted in the detailed design phase (i.e., not included in the Stormwater Control Plan)
- Specifications of construction for BMPs, including sand or soil, compaction, pipe materials and bedding.

In the final O&M Plan, note field changes to design drawings, including changes to any of the following:

- Location and layouts of inflow piping, flow splitter boxes, and piping to off-site discharge
- Depths and layering of soil, sand, or gravel
- Placement of filter fabric or geotextiles
- Changes or substitutions in soil or other materials.
- Natural soils encountered (e.g. sand or clay lenses)

4: Prepare Customized Maintenance Plans

Prepare a maintenance plan, schedule, and inspection checklists (routine, annual, and after major storms) for each BMP. Plans and schedules for two or more similar BMPs on the same site may be combined.

Use the following resources to prepare your customized maintenance plan, schedule, and checklists.

- Specific information noted in Steps 2 and 3, above.
- Other input from the BMP designer, municipal staff, or other sources.
- BMP Operation and Maintenance Fact Sheets.

Note any particular characteristics or circumstances that could require attention in the future, and include any troubleshooting advice.

Also include manufacturer's data, operating manuals, and maintenance requirements for any:

- Pumps or other mechanical equipment.
- Proprietary devices used as BMPs.

Manufacturers' publications should be referenced in the text (including models and serial numbers where available). Copies of the manufacturers' publications should be included as an attachment in the back of your O&M Plan or as a separate document.

5: Compile O&M Plan

Assemble and make copies of your O&M Plan. One copy must be submitted to the municipality, and at least one copy kept on-site. Here are some suggestions for formatting the O&M Plan:

- Format plans to 8½" x 11" to facilitate duplication, filing, and handling.
- Include the revision date in the footer on each page.
- Scan graphics and incorporate with text into a single electronic file. Keep the electronic file backed-up so that copies of the O&M Plan can be made if the hard-copy is lost or damaged.

6: Updates

Your Stormwater Control Operation and Maintenance Plan will be a living document.

Operation and maintenance personnel may change; mechanical equipment may be replaced, and additional maintenance procedures may be needed. Throughout these changes, the O&M Plan must be kept up-to-date.

Updates may be transmitted to your municipality at any time. However, at a minimum, updates to the O&M Plan must accompany the annual inspection report. These updates should be placed in reverse chronological order (most recent at the top) in Section 1 of the binder. If the entire O&M Plan is updated, as it should be from time to time, these updates should be removed from the first section, but may be filed (perhaps in the back of the binder) for possible future reference.

References and Resources

- RWQCB Order 01-119, Provision C.3.e
- *C.3 Stormwater Handbook: Guidance for Implementing Stormwater Requirements for New and Redevelopment Projects, Final Draft, June 2004.* Santa Clara Valley Urban Runoff Pollution Prevention Program.
- *Start at the Source* (BASMAA, 1999) pp. 139-145.
- *Urban Runoff Quality Management* (WEF/ASCE, 1998). pp 186-189.
- *Stormwater Management Manual* (Portland, 2002). Chapter 6.0.
- *California Storm Water Best Management Practice Handbooks* (CASQA, 2003) Fact Sheets
  Bioretention
  Drain Insert
  Extended Detention Basin
  Infiltration Basin
  Infiltration Trench
  Multiple Systems
  Media Filter (TC40)
  Media Filter (MP40)
  Retention/Irrigation
  Vegetated Buffer Strip
  Vegetated Swale
  Vortex Separator
  Water Quality Inlet
  Wet Pond
  Wet Vault
  Wetland
- SCVURPPP Operation & Maintenance Fact Sheets:
  Exfiltration Trench
  Hydrodynamic Separators
  Planter Boxes
  Porous Pavement
  Roof Gardens
  Underground Detention Systems
- Best Management Practices Guide (Public Telecommunications Center for Hampton Roads, 2002).
- Georgia Stormwater Manual Structural Control Maintenance Checklists. Atlanta Regional Commission, 2001. www.georgiastormwater.com
- Operation, Maintenance and Management of Stormwater Management (Watershed Management Institute, 1997). Order Form.

9/20/04

Recording Requested By:
CITY OF ______________________

Return to: **CITY OF ______________**
City Clerk
____
_________________, CA 945

Document Title

CITY OF __________

STORMWATER MANAGEMENT FACILITIES OPERATIONS
AND MAINTENCE AGREEMENT
AND RIGHT OF ENTRY

PROJECT: ____________________

OWNERS NAMES: ___________

ASSESSOR'S PARCEL NUMBER: ________

STORMWATER MANAGEMENT FACILITIES
OPERATION AND MAINTENANCE AGREEMENT
AND RIGHT OF ENTRY

This Stormwater Management Facilities Operation and Maintenance Agreement and Right of Entry ("Agreement") is made and entered into this ____________ day of ________________, 20___, by and between ____, (hereinafter referred to as "Property Owner") and the City of ______________, a municipal corporation ("City").

RECITALS:

This Agreement is made and entered into with reference to the following facts:

WHEREAS, the Permanent Stormwater Pollution Prevention Measures (hereinafter referred to as Best Management Practices or "BMP") have been installed in and must be maintained for the development called ____________________________________, located at ________________________________, _____________, Contra Costa County, State of California and more particularly described on Exhibit A attached hereto and incorporated herein by reference (the "property" or "real property"); and,

WHEREAS, the Property Owner is the owner of real property more particularly described on the attached as Exhibit A; and,

WHEREAS, the City is the owner of ____________ Street and its storm drains that are adjacent to the property, and

WHEREAS, the City's Stormwater Management and Discharge Control Ordinance ("Ordinance") requires proper operation and maintenance of the BMP constructed on this property; and,

WHEREAS, the development conditions of approval require that BMP, as shown on the approved Stormwater Control Plan be constructed and properly operated and maintained by the Property Owner; and,

WHEREAS, the City has approved the Stormwater Control Operation and Maintenance Plan prepared by ____on the day of _______________________, 20 ___, as this Plan may be subsequently modified from time to time with City's approval; and,

WHEREAS, the Stormwater Control Operation and Maintenance Plan includes an annual inspection checklist for the BMP constructed on this property, and,

WHEREAS, this Agreement memorializes the Property Owner's maintenance, operations, and inspection obligations under the City's Ordinance and the approved Plans.

NOW, THEREFORE, in consideration of the foregoing premises, the mutual covenants contained herein, and the following terms and conditions, the parties hereto agree as follows:

SECTION 1

Responsibility for Operation and Maintenance: The Property Owner will make available copies of the approved Stormwater Control Plan and approved Stormwater Control Operation and Maintenance Plan (hereinafter the "Plans") at the property with the facility or property manager and must maintain the BMP in good working condition acceptable to the City for the life of the project, and in compliance with the Ordinance and the approved Plans. Upon transfer of the property, the Property Owner shall provide the new owner with the current Plans.

SECTION 2

Inspection by Property Owner: The Property Owner, at its own expense, shall conduct annual inspections during the month of ________ or _________ of each year. The annual inspection report shall include completion of the checklist described in the approved Stormwater Operation and Maintenance Plan. A qualified independent inspector who is acceptable to the City must inspect the BMP. The Property Owner must submit the inspection report on these BMP to the City Engineer within 30 days after each inspection. A processing fee established in the City's standard fee schedule shall accompany the annual inspection report.

SECTION 3

Right of Entry and Facility Inspection by the City: The Property Owner hereby grants permission to the City, its authorized agents and employees, and the Central Contra Costa Sanitary District, the Contra Costa County Fire Protection District, County Environmental Health Department, the Contra Costa Mosquito and Vector Control District, and the Regional Water Quality Control Board to enter the property, and to inspect the BMP whenever any of the foregoing entities deems necessary to enforce provisions of the City's Stormwater and Urban Runoff Pollution Control Ordinance. These entities may enter the premises at any reasonable time to inspect the premises and BMP operation, to inspect and copy records related to storm water compliance, and to collect samples and take measurements. Whenever possible, these entities will provide notice prior to entry.

SECTION 4

Failure to Perform Required Facility Repairs or Maintenance by the Property Owner: If the Property Owner or its successors fail to maintain the BMP in good working order and in accordance with the approved Plans and the City's Ordinance, the City, with prior notice, may enter the property to return the BMP to good working order. The City is under no obligation to maintain or repair the BMP, and this Agreement may not be construed to impose any such obligation on the City. If the City, under this section takes any action to return the BMP to good working order, the Property Owner shall reimburse the City for all the costs incurred by the City. The City will provide the Property Owner with an itemized invoice of the City's costs and the Property Owner will have 30 days to pay the invoice. If the Property Owner fails to pay the invoice within 30 days, the City may secure a lien against the real property of the Property Owner in the amount of such costs. In addition the City may make the cost of abatement of the nuisance caused by the failure to maintain the BMP a special assessment against the property that may be collected at the same time and in the same manner as ordinary municipal taxes are collected as provided in Government Code section 38773.5. This Section 4 does not prohibit the City from pursuing other legal recourse against the Property Owner.

SECTION 5

Indemnity: The Property Owner agrees to defend, indemnify and holds harmless the City, its officials, employees and its authorized agents from any and all damages, accidents, casualties, occurrences or claims which might arise or be asserted against the City and which are in any way connected with the construction, operation, presence, existence or maintenance of the BMP by the Property Owner, or from any personal injury or property damage that may result from the City or other public entities entering the property under Section 3 or 4.

SECTION 6

Successors and Assigns: The covenants of the Property Owner set forth in numbered Sections 1 through 5 above shall run with the land, and the burdens thereof shall be binding upon each and every part of the property and upon the Property Owner, its successors and assigns in ownership (or any interest therein), for the benefit of _____________ Street and its storm drains and each and every part thereof and said covenants shall inure to the benefit of and be enforceable by the City, its successors and assigns in ownership of each and every part of the Street and storm drains.

SECTION 7

Severability: Invalidation of any one of the provisions of this Agreement shall in no way effect any other provisions and all other provisions shall remain in full force and effect.

Recommended for approval:	City of _____________:
______________________________	______________________________
City Engineer	Mayor
Reviewed by:	Attest:
______________________________	______________________________
City Attorney	City Clerk

Property Owners:

____

____

Attachments: Acknowledgements
Exhibit A

ALL PURPOSE ACKNOWLEDGMENT

State of California)
) s.s.
County of ______________)

On __________________________, before me,
___________________________________, personally appeared
____,
______ personally known to me;
______ or proved to me on the basis of satisfactory evidence to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s) or the entity upon behalf of which the person(s) acted, executed the instrument.

WITNESS my hand and official seal. (SEAL)

____
Signature of Notary Public

CAPACITY CLAIMED BY SIGNER:

Though statute does not require the notary to fill in the data below, doing so may prove invaluable to persons relying on the document.

______ Individual(s)
______ Corporate Officer(s) Titles ______________ and _____________
______ Partner(s) _____ Limited _____ General
______ Attorney-in-Fact
______ Trustee(s)
______ Guardian/Conservator
______ Other : ____

Signer is representing: ____

ATTENTION NOTARY: Although the information requested below is optional, it could prevent fraudulent attachment of this certificate to unauthorized document.

Title or type of document ____
Number of pages: ___________ Date of document: __________________________
Signer(s) other than named above: _______________________________________

THIS CERTIFICATE MUST BE ATTACHED TO THE DOCUMENT DESCRIBED ABOVE

EXHIBIT A
Legal description

Designation of Individuals Responsible for Stormwater Treatment BMP Operation and Maintenance	
Date Completed	
Facility Name	
Facility Address	
Designated Contact for Operation and Maintenance	
Name:	Title or Position:
Telephone:	Alternate Telephone:
Email:	
Off-Hours or Emergency Contact	
Name:	Title or Position:
Telephone:	Alternate Telephone:
Email:	
Corporate Officer (authorized to execute contracts with the City, Town, or County)	
Name:	Title or Position:
Address:	
Telephone:	Alternate Telephone:
Email:	

Stormwater BMP Inspection and Maintenance Log

Facility Name	
Address	
Begin Date	End Date

Date	BMP ID#	BMP Description	Inspected by:	Cause for Inspection	Exceptions Noted	Comments and Actions Taken

Instructions: Record all inspections and maintenance for all treatment BMPs on this form. Use additional log sheets and/or attach extended comments or documentation as necessary. Submit a copy of the completed log with the annual independent inspectors' report to the municipality, and start a new log at that time.

- BMP ID# — Always use ID# from the Operation and Maintenance Manual.
- Inspected by — Note all inspections and maintenance on this form, including the required independent annual inspection.
- Cause for inspection — Note if the inspection is routine, pre-rainy-season, post-storm, annual, or in response to a noted problem or complaint.
- Exceptions noted — Note any condition that requires correction or indicates a need for maintenance.
- Comments and actions taken — Describe any maintenance done and need for follow-up.

Sample Contents of Inspector's Report

I. General
   A. Date and time of site visit
   B. Reason for inspection (e.g., routine/annual, follow-up, by municipality request, or response to complaint)
   C. Weather/rainfall
   D. Personnel participating
   E. Ability to obtain access to the site

II. Review of Stormwater Control Operation and Maintenance Plan
   A. Ability to obtain and review on-site copy of plan
   B. Date of last update to plan
   C. Sections out-of-date and updates needed
      (1) Contact information for site personnel
      (2) Information on BMPs
      (3) Records of previous inspections
   D. Review of maintenance logs
      (1) Comparison to maintenance schedule. Note exceptions.

III. Results of Site Inspection
   A. Overall condition of site and any exceptional circumstances (e.g., construction in progress, flooding)
   B. For each BMP listed in the Stormwater Control Operation and Maintenance Plan
      (1) Items inspected
      (2) Exceptions noted
      (3) Corrective actions needed
         (a) Exceptions not affecting BMP performance (correct and re-inspect in one year)
         (b) Exceptions affecting BMP performance (correct and re-inspect immediately)

IV. Compliance Status
   A. In compliance—no corrective actions required, or
   B. In compliance—implement corrective actions and re-inspect in one year, or
   C. Not in compliance—implement corrective actions and re-inspect

V. Summary and Recommendations
   A. Note any required follow-up and schedule re-inspection if necessary

Appendix

G

Example Stormwater Control Plans

Stormwater Control Plans that illustrate the instructions in the Stormwater C.3 Guidebook

[Examples in preparation. Check www.cccleanwater.org/construction/nd.php for updates.]

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Appendix

H

Contra Costa Hydrology Data

See instructions in Chapter Five.

Appendix H consists of two graphical design aids:

1. Contra Costa County Flood Control and Water Conservation District (CCCFCWCD) Drawing B-166, "Mean Seasonal Isohyets Compiled from Precipitation Records 1879-1973." The 11" x 17" drawing is not reproduced here in the *Guidebook*, but may be downloaded in Adobe Acrobat format from the Program's C.3 web page at www.cccleanwater.org/construction/nd.php. Printed copies are available from the Contra Costa County Public Works Department.

2. "Unit Basin Storage Size for 80% Capture." Technical background is in the memorandum, "Rainfall Data Analysis and Guidance for Sizing Treatment BMPs" (Geosyntec Consultants, 2005), available from the Contra Costa Clean Water Program.

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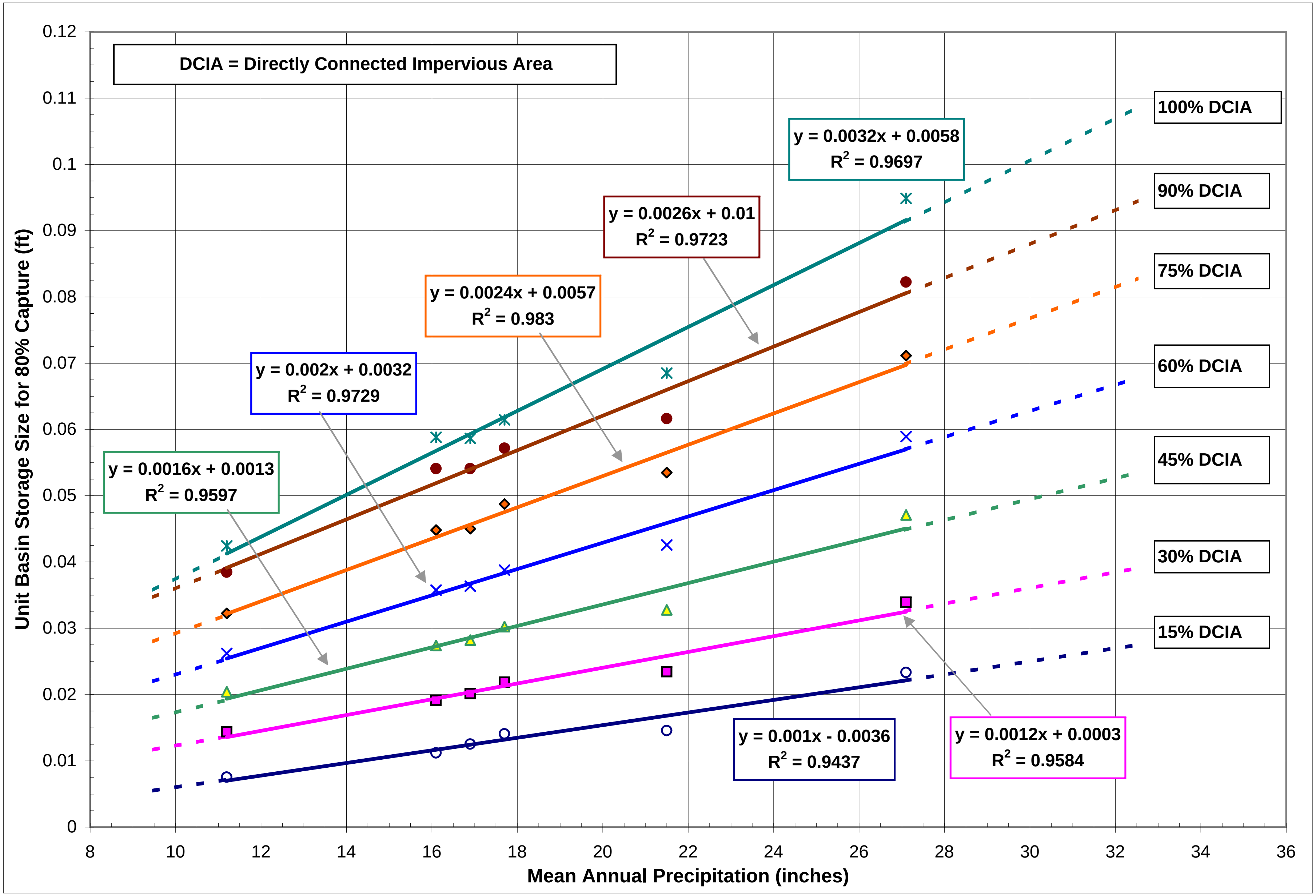
DCIA = Directly Connected Impervious Area
100% DCIA
90% DCIA
75% DCIA
60% DCIA
45% DCIA
30% DCIA
15% DCIA
y = 0.0032x + 0.0058
R2 = 0.9697
y = 0.0026x + 0.01
R2 = 0.9723
y = 0.0024x + 0.0057
R2 = 0.983
y = 0.002x + 0.0032
R2 = 0.9729
y = 0.0016x + 0.0013
R2 = 0.9597
y = 0.001x - 0.0036
R2 = 0.9437
y = 0.0012x + 0.0003
R2 = 0.9584
Unit Basin Storage Size for 80% Capture (ft)
Mean Annual Precipitation (inches)
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0.11
0.12
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36

Appendix

I

BMP Sizing Spreadsheet

See the instructions in Chapter Five..

The spreadsheet may be downloaded in .xls format at www.cccleanwater.org/construction/nd.php.

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Contra Costa Clean Water Program

Treatment BMP Sizing Worksheet

See *Stormwater C.3 Guidebook* Chapter 5 for Instructions

Project Name:		Date:	
Address/Location:		APN:	

Total Project Area (in sq. ft.; exclude areas of site to remain undeveloped): ___ Impervious: ___ Pervious: 0

Table 1. Pervious Areas

Area ID	Surface	Self-retaining Area (sq. ft.)	Non-self retaining Area (sq. ft.)	"C" Factor	Size * C
					0
					0
					0
					0
					0
					0
Totals		0	0		0

Runoff factors for non-self-retaining pervious areas

Surface	"C"
Turf	0.1
Landscape	0.1
Crushed aggregate	0.1
Pervious Concrete	0.6
Pervious Asphalt	0.55

Table 2. Impervious Areas Draining to Planters, Swales, and Bioretention Areas

Area ID	Surface	Size (square feet)	Type and ID# of BMP to be used	Area Served by BMP (SF)	Sizing Factor (=0.04)	Minimum Surface Area	Surface Area as designed
					0.04	0	
					0.04	0	
					0.04	0	
					0.04	0	
					0.04	0	
					0.04	0	
					0.04	0	
					0.04	0	
					0.04	0	
					0.04	0	
					0.04	0	
					0.04	0	
Total		0		0			

Table 3. Impervious Areas Draining to Infiltration Basins, Infiltration Trenches, and Dry Wells

Enter Mean Annual Precipitation from Figure B-166

Area ID (as indicated on site drawing)	Percent Directly Connected Impervious Area	Amount of Area (SF)	BMP ID# and Type	Area served by BMP (SF)	Required Water Quality Volume (CF)	Proposed depth (ft.)	Porosity of fill (Rock = 35%; Basin = 100%)	Minimum required BMP Surface Area (SF)	Proposed Surface Area (SF)	Infiltration Rate (in./hr.)	Time to drain (hours)
					0						
					0						
					0						
					0						
					0						
					0						
Total		0		0							

Sizing of Conventional BMPs to Serve Entire Site:

	Table 1:	Table 2:	Table 3:	Total	Remaining impervious area	Remaining Total Area	Percent DCIA of remaining area	Required Water Quality Volume
Volume-based BMPs	0	0	0	0	0	0	0	0
OR							Composite "C" Factor	Design Flow Rate (cfs)
Flow-Based BMPs					0	0	0	0

Appendix

J

Example BMP Operation & Maintenance Plans

To be available later in 2005. Check www.cccleanwater.org/construction/nd.php for updates.

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Appendix

K

Local BMP Operation & Maintenance Verification Program

Information on how your local municipality documents, inspects, and verifies maintenance for stormwater treatment BMPs. See Chapter Six. Request from your municipal planning department.

The Contra Costa Clean Water Program C.3 web page includes links to each Contra Costa municipality's C.3 information.